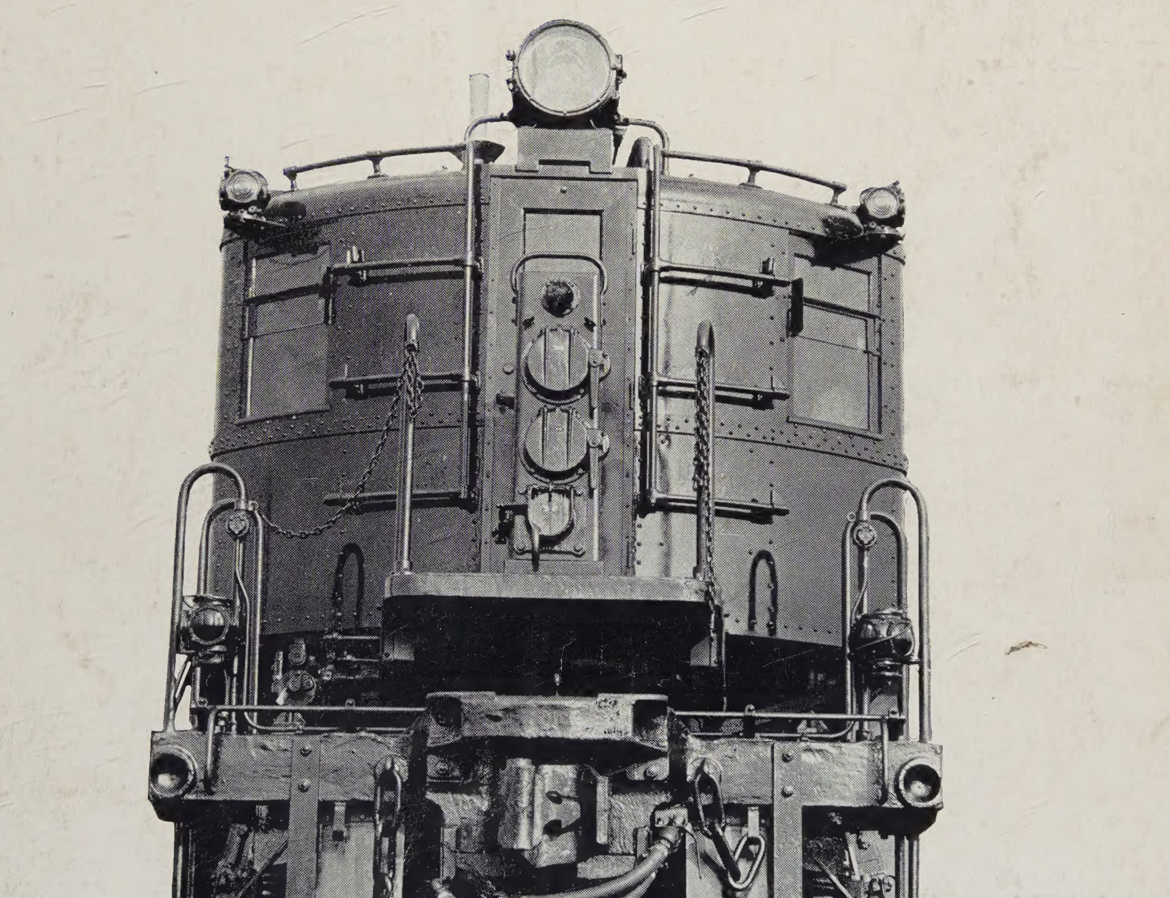
Electrical Engineering

October
1931



Published by
American Institute
of Electrical Engineers, New York

FUTURE MEETINGS

of the

American Institute of Electrical Engineers

Place	*Dates*	*Nature*	*Latest Date for Receipt of Manuscripts*
Kansas City, Mo.	Oct. 22-24, 1931	District Meeting	(Closed)
New York, N. Y.	Jan. 25-29, 1932	Winter Convention	Oct. 26, 1931
Milwaukee, Wis.	March 14-16, 1932	District Meeting	Dec. 14, 1931
Providence, R. I.	May - 1932	District Meeting	Feb. - 1932
Cleveland, Ohio	June 20-24, 1932	Summer Convention	March 20, 1932
Vancouver, B. C.	Aug. 29- Sept. 21, 1932	Pacific Coast Convention	May 29, 1932

NOTE: Members who are contemplating submitting papers for presentation at any of the above meetings should communicate promptly with Institute headquarters, 33 West 39th Street, New York, N. Y., so that their papers may be docketed for consideration by the Meetings and Papers Committee, as programs for all meetings are formulated several months in advance. Upon receipt of this notification, Institute headquarters will mail to each prospective author information in regard to the Institute's rules relating to the preparation of manuscript and illustrations.

MEETINGS OF OTHER SOCIETIES

NATIONAL SAFETY COUNCIL, Stevens Hotel, Chicago, Ill., October 12-16, 1931. (W. H. Cameron, managing director, 20 North Wacker Drive, Chicago, Ill.)

ILLUMINATING ENGINEERING SOCIETY, William Penn Hotel, Pittsburgh, Pa., October 13-16, 1931. (E. H. Hobbie, 29 West Thirty-Ninth Street, New York, N. Y.)

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, Jefferson Hotel, Richmond, Va., October 20-23, 1931. (J. B. Walker, 270 Madison Ave., New York, N. Y.)

NATIONAL BATTERY MANUFACTURERS' ASSOCIATION, seventh annual convention, Hollendon Hotel, Cleveland, Ohio, October 22-23, 1931. (W. J. Parker, 7 East Forty-Fourth Street, New York, N. Y.)

NATIONAL ELECTRICAL WHOLESALERS' ASSOCIATION, Starrett's Netherland Plaza, Cincinnati, Ohio, November 9-11, 1931. (E. Donald Tolles, 165 Broadway, New York, N. Y.)

NATIONAL RESEARCH COUNCIL, fourth annual conference of committee on electrical insulation of the division of engineering and industrial research, Harvard University, Cambridge, Mass., November 13-14, 1931. (J. B. Whitehead, chairman, Johns Hopkins University, Baltimore, Md.)

THIRD INTERNATIONAL CONFERENCE ON BITUMINOUS COAL, Carnegie Institute of Technology, Pittsburgh, Pa., November 16-21, 1931. (T. R. Alexander, secretary, Schenley Park, Pittsburgh, Pa.)

SOUTH AMERICAN ELECTROTECHNICAL CONGRESS, Buenos Aires, July 4-11, 1932. (R. F. Ascher, general secretary, Paseo Colon 185, Buenos Aires, S. A.)

Published Monthly by

American Institute of Electrical Engineers

(Founded May 13, 1884)

33 West 39th Street, New York, N. Y.

Electrical Engineering

Registered U. S. Patent Office

Volume 50
No. 10

The JOURNAL of the A.I.E.E. for October 1931

SUBSCRIPTION RATES—$10 per year to United States, Mexico, Cuba, Porto Rico, Hawaii and the Philippine Islands, Central America, South America, Haiti, Spain and Spanish Colonies; $10.50 to Canada; $11 to all other countries. Single copy $1.

CHANGE OF ADDRESS—requests must be received by the fifteenth of the month to be effective with the succeeding issue. Copies undelivered due to incorrect address cannot be replaced without charge. Be sure to specify both old and new addresses and any change in business affiliation.

ADVERTISING COPY — changes must be received by the fifteenth of the month to be effective for the issue of the month succeeding.

ENTERED as second class matter at the Post Office, New York, N. Y., May 10, 1905, under the Act of Congress March 3, 1879. Accepted for mailing at special postage rates provided for in Section 1103, Act of October 3, 1917, authorized on August 3, 1918.

ELECTRICAL ENGINEERING is indexed in Industrial Arts Index.

Printed in the United States of America. Number of copies this issue—

23,000

This Month—

Front Cover

A monster of modern transportation. One of a fleet of electric locomotives recently placed in service by the New York Central Railroad. Six motors give a continuous rating of 2,025 hp. (2,500 hp. 1 hr.) and provide a maximum starting tractive effort of 66,500 lb., a 1-hr. rating of 41,800 lb. at 22 m. p. h., and a continuous rating of 31,620 lb. at 24 m. p. h.

—General Electric Co. Photo.

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NEWS section this month is replete with echoes of the recent A. I. E. E. Pacific Coast "vacation" convention. (*See pp. 832-5.*) Discussion on the technical papers presented is summarized also. (*See pp. 835-7.*)

THE electrical engineering profession suffered a distinct loss in the recent deaths of four of its noted members. (*See pp. 843-4.*)

THE widely heralded plan for stabilizing industry proposed by Gerard Swope (F'22) is presented in full in this issue. (*See pp. 816-9.*)

LETTERS received by the editor during the past month reveal increasing interest among readers especially in those articles dealing with the effects of engineering upon human relationships. (*See pp. 840-1.*)

LAST call is issued for the impending A. I. E. E. Kansas City meeting. (*See p. 834.*)

TESTS show that power-frequency corona is of no value in damping transmission-line surges. (*See pp. 798-801.*)

A NEW scheme of relaying with only two pilot wires instead of the usual four, materially reduces the cost of this type of protection. (*See pp. 824-6.*)

ENGINEERING FOUNDATION'S symposium, "Has Man Benefited by Engineering Progress," is continued this month by a protest against the indirect bonus system. (*See pp. 812-3.*)

SOME of the mysteries of mercury arc rectifiers are revealed in three articles by five engineers intimately connected with their development and application. (*See pp. 788-98.*)

A SERIES of tests involving all stages of the discharge casts further light upon the complex phenomena associated with the electric arc as used in welding. (*See pp. 827-9.*)

THOSE interested in electric motors and their applications are referred to two articles on special designs of synchronous motors (*see pp. 814-5 and 819-23*) and a third dealing with repulsion starting for capacitor motors (*see pp. 830-1*).

COMMUNICATION plays an important part in power system operation as is well demonstrated in a group of five articles outlining the fundamental requirements of power companies and describing the facilities in use on four typical systems. These represent the joint efforts of six power engineers and three communication experts of the Bell telephone system. (*See pp. 802-812.*)

Arc Welding in Building Construction

In this article are presented data obtained during the construction of the tallest building erected to date using the electric arc welding process. The outstanding advantages of this method of construction over the older method of riveting are (1) an almost complete absence of noise, and (2) the reduced steel tonnage required.

By
P. N. VINTHER Dallas Pwr. & Lt. Co., Dallas, Texas

WHILE electric arc welding has been used experimentally or commercially for more than half a century, its use in building construction extends back only three or four years. During these few years it has been applied successively to small, then to large and still larger projects until now because of its economy and quietness it is beginning to find favor in many quarters.

Because of its newness, most established building codes do not take cognizance of arc welding as a method of building construction. The first step in this direction was taken by the Pacific Coast Building Officials' Conference, which has included in its uniform building code the authority to use arc welding and has set forth therein the essential elements required by engineers and architects for working out designs of welded joints in steel beams and columns. A great many cities since have amended their codes to include arc welding; most of them have based their amendment on this Pacific Coast Building Officials' code. More and more municipalities are considering the advisability of adopting arc welding on steel construction as a means of obtaining quiet in the vicinities of hospitals, hotels, schools, and office buildings; wherever it has been used much satisfaction is evidenced.

The city of Dallas, principally through the efforts of local representatives of welding equipment manufacturers, legalized arc welding by ordinance in 1929. Accordingly the Dallas Power and Light Company, recognizing an opportunity to promote the use of electricity in a new field and to create a more livable condition for employees and neighbors during construction, concluded after thorough investigation to use welding in place of riveting in their new office building.

Nineteen-story arc-welded building of the Dallas (Tex.) Power & Light Company

This building is about 246 ft. high from basement floor to top of tank room roof, and is the tallest in the world to have employed this process to date. It consists of a nineteen-story main shaft (with basement) approximately 100 x 100 ft. at the base, and a 60 x 100-ft. connecting annex of two stories and basement. The main shaft is of modern design having an offset on the front at the sixth floor level and sym-

From "Electric Arc Welding in Building Construction," (No. 31M8) to be presented at the A. I. E. E. South West District meeting, Kansas City, Mo., Oct. 22-24, 1931.

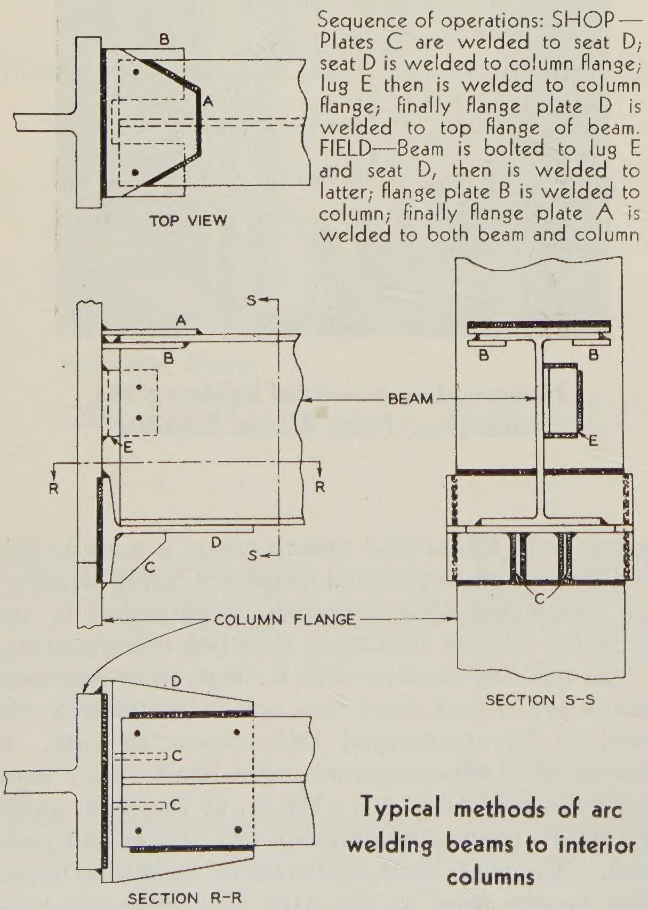
metrical setbacks on the two sides at the fourth and twelfth floor levels. The framing of this portion of the building consists of 25 H-section columns at the base spaced approximately 25 x 25 ft. and creating four 25-ft. bays each way. The width of the fourth floor setback is one-half a bay so that the outside columns from the fourth to the twelfth floors are carried on beams in the fourth floor. The twelfth floor offset is also half a bay, leaving the tower from the twelfth floor up two bays wide by the original four long, or approximately 50 x 100 ft. The sixth floor offset across the front is a minor one of only three or four feet and is carried by a second set of columns adjacent to the outside row, the outside row stopping with the offset and the adjacent row extending through to the top.

The second floor of the annex and the seventeenth floor of the main shaft are auditoriums. The second floor auditorium is spanned by five welded Warren trusses approximately 5 x 60 ft. The seventeenth floor auditorium, which really is two stories high, is spanned by three 12 x 50-ft. shop- and field-welded trusses, which not only support the ceiling of the seventeenth floor but carry on their bottom chords the nineteenth floor and on their top chords the roof, so that the nineteenth floor has the truss height for story height. The total weight of the steel is 1,170 tons for the main building and 45 tons for the annex. The steel was fireproofed with concrete, all of the slabs being of the pan and joist type poured on removable wooden forms. The building is provided with heavy wind bracing in both directions.

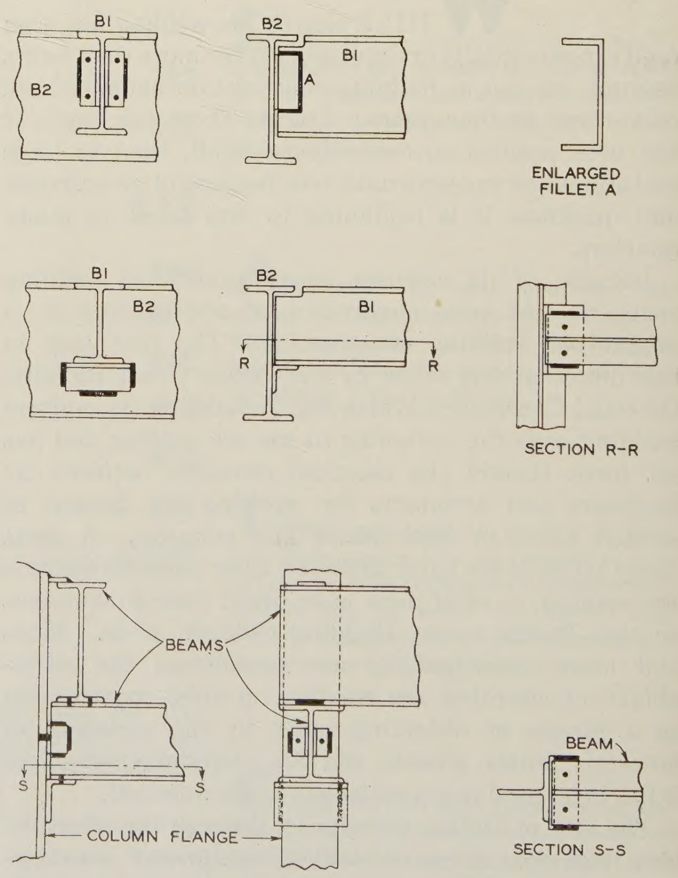
Since the success of welding depends upon the skill of the welders, the utmost care was used in selecting and training the mechanics employed. Each applicant was required to pass a rigid proficiency test before he was allowed to work. Only those welders whose specimens broke down at or above certain minimums set up for each type of weld were considered and then only provided their specimens showed uniformity in strength and appearance. While a good and uniform appearance in a weld does not of itself contribute directly to strength it is interesting to note that almost invariably the best looking work tests highest. For this reason a visual inspection is as effective as any other means yet devised, although certain mechanical and electrical methods now are being developed that no doubt some day will come into general use as an aid to the eye and sense.

Welding equipment consisted of five 200-ampere portable motor-driven units of standard design, each used by a single mechanic.

The joining of the horizontal members or a horizontal



Typical methods of arc welding beams to interior columns



Typical methods of arc welding small beams to larger beams and columns

Connecting angles are shop welded to small beams, and field welded to larger beams or columns. Shelf angles are shop welded to larger beams or columns

member to a vertical member was accomplished by resting one member upon and field-welding it to a shelf shop-welded to the other. These shelves afforded not only a rest for members until welding could be completed, but also provided location for temporary construction bolts which, together with the customary cables and turnbuckles, were used in erection. Additional angles, I's and gussets then were added and the necessary amount of welding, measured in inches, was applied to provide the required strength. Care was exercised in the location and arrangement of these auxiliary pieces that as much of the welding as possible might be done at the shop and that overhead welding might be held to a minimum. Column splices were made by butting the ends together at the field and adding splice and filler plates, then welding to the required strength. Typical connection details are shown in the illustrations.

Most of the pertinent data collected during erection is given in the accompanying tabulation.

Arc-welding data for the Dallas Power & Light Company's nineteen-story building

Item	Description		Shop	Field
1.	Electrode bought	Lb.	7,100	4,650
2.	Electrode melted (assumed 70%)	Lb.	4,970	3,255
3.	Energy used	Kw-hr.	No record	9,460
4.	Total steel welded	Tons	1,215*	1,170*
5.	Welders' time	Man-hr.	3,140	1,768
6.	Total length of 3/8-in. fillets	In.	97,500	56,415
7.	Total length of 1/2-in. fillets	In.	25,400	17,842
8.	Total length of all fillets	In.	122,900	74,257
9.	Fillet per ton of steel	In.	101.2	63.5
10.	Fillet deposited per man per hour	In.	29.2	42.0
11.	Fillet deposited per man per 8-hr. day	Ft.	26.13	28.0
12.	Fillet deposited per lb. of electrode bought	In.	17.3	16.0
13.	Fillet deposited per lb. of electrode melted	In.	24.7	22.8
14.	Fillet deposited per kw-hr	In.	—	7.9
15.	Electrode melted per kw-hr	Lb.	—	0.34
16.	Energy required to melt 1 lb. electrode	Kw-hr.	—	2.90
17.	Welding man-hours per ton of steel	Man-hr.	2.58	1.51
18.	Electrode bought per ton of steel	Lb.	5.84	3.98
19.	Electrode melted per ton of steel	Lb.	4.08	2.78
20.	Electrode melted per hour per welder	Lb.	1.58	1.84
21.	Electrode melted per linear inch of fillet	Lb.	0.040	0.044
22.	Energy required per ton of steel	Kw-hr.	—	8.09

*Difference between shop and field tonnage due to 45 tons in a two-story wing not included in record.

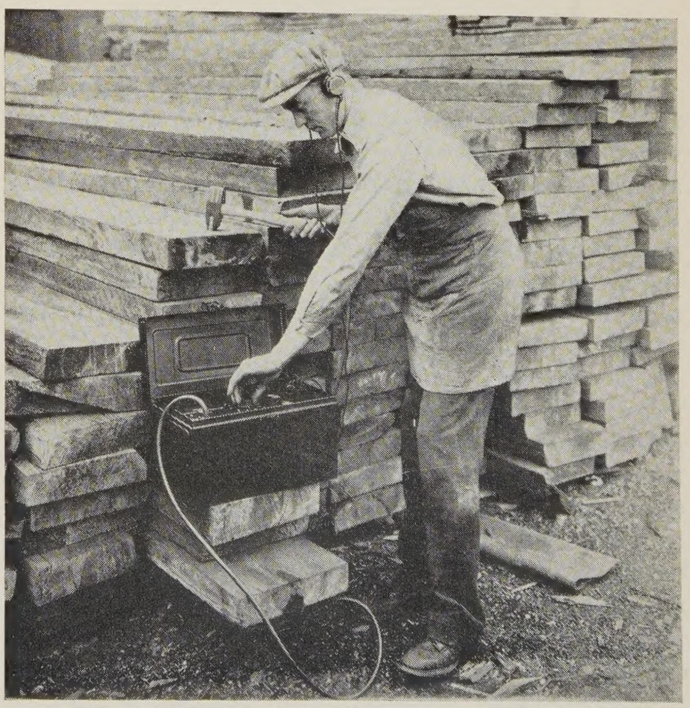
Erection of the building was begun on July 18, 1930, and was completed September 3 of the same year. Field-welding operations were started on July 23, being completed September 11. In the completed building only two or three evidences remain to testify against the welding process and each of these could have been eliminated had the designers of the building possessed the experience that now is theirs.

Great progress in welding is being made. Many new problems are encountered on every job and are being worked out. The summation of the solutions of all these problems will constitute a goodly store of knowledge from which the architect and engineer may be able to design simply and practically and the contractor to fabricate economically. Even then prejudice in the minds of the non-progressive element will have to be overcome. Possibly new weights and shapes of members will have to be devised in order to reap most fully the benefits of the possibilities for reduced tonnage. Whatever are the obstacles in the path of the development in the art they all will be overcome with time. While at present it cannot be said that welding is due to supplant riveting in every kind of steel job, there is no doubt that the increasingly congested condition of commercial areas and the increasingly insistent demand on the part of the people therein for quiet will keep engineers, architects, and scientists busy.

Lumber Moisture Content Determined Electrically

THE OPERATION of determining accurately the amount of moisture present in lumber is reported to be greatly simplified by an electrical apparatus developed by C. G. Suits of the General Electric research laboratory, Schenectady, N. Y., and M. E. Dunlap of the United States Forest Products Laboratory at Madison, Wis.

The device utilizes simple tuned circuits involving two neon glow lamps. One of the neon lamps is



Portable electric lumber moisture tester

connected across a fixed condenser so adjusted that as the condenser successively builds up and discharges, this tube produces a characteristic red flash at the rate of about once per second. The other neon tube and its associated condenser are in series with the knife-edged electrodes on the specially treated wooden hammer. These electrodes, when driven into the grain of the lumber to be tested, complete an electrical circuit the characteristics of which depend upon the resistance of the wood between the two hammer electrodes. The rate at which this condenser builds up its charge depends upon the conductivity, and therefore upon the moisture content, of the wood under test. By means of a variable condenser this second tube circuit is adjusted so that the two tubes flash simultaneously, thus permitting the dial reading of the variable condenser to be calibrated to reveal the percentage of moisture in the lumber under test. Ear-phones may be substituted for the neon tubes where bright sunlight interferes with the visual effect of the tube flash.

Investigations indicate that with the exception of certain heavy imported woods, dependence may be placed upon the determination of moisture content as revealed by such a resistance test.

Solving the Mystery of Mercury Arc Rectifiers

By
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Non-member

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Associate A. I. E. E.

Both of
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The three factors most important in mercury arc rectifiers are vapor pressure, arc-drop, and geometry of the anode housing. Investigations of such factors described in this article, have increased the capacity of rectifiers considerably and made it possible to eliminate several undesirable features of their operation.

EXPERIMENTAL research during the last three years has removed much of the mystery which shrouded the mercury arc rectifier, and made it a piece of standard electrical apparatus comparable to the motor and transformer. Much remains to be learned but these investigations have expanded greatly the range of current and voltage that can be handled by a rectifier and have indicated the path for still further progress.

The differences between the early rectifiers and the more modern type illustrated in Fig. 1 are mostly in the neighborhood of the anodes. One conspicuous change may be dismissed with a very brief statement, *viz.*, the change from mercury-cooled iron anodes supported by porcelain bushings, to graphite anodes with micalex bushings. The micalex seal is made from a mixture of mica and lead borate glass, fused and molded under high pressure, yielding a vacuum-tight seal of high mechanical and dielectric strength. This allows the clamped seal to be metal-metal instead of metal-porcelain, thus avoiding differential lateral expansion.

The normal operating requirements of a rectifier are very simple:

1. It must start easily, *i.e.*, it must begin rectifying whenever the a-c. crest voltage exceeds the d-c. line voltage by a small margin, of the order of 20 volts.

2. It must not arc back, *i.e.*, allow current to pass in the reverse direction.

3. The voltage drop between anode and cathode, when current is flowing, must be low enough to meet the efficiency requirements. The practical limits of voltage drop, which are approximately 20 volts minimum and 40 volts maximum, are generally satisfactory for line voltages of 500 or more, but are too high for 250-volt operation. The hot-cathode rectifier promises to fill this gap.

4. Voltage regulation will be required in the future. This is a circuit function rather than a rectifier function in the case of a simple rectifier, and can be accomplished by transformer compounding; but grid-controlled rectifiers of the type illustrated in Fig. 1, called thyratrons, can be made to give any desired regulation without compounding.

The arc-back requirement has received most attention up to the present, because the greatest electrical sin of today is interruption of service. When a rectifier arcs back it is a two-way conductor instead of one-way and hence constitutes a short circuit of the a-c. supply line as well as the d-c. line or network which it feeds. The harm done by such short circuits, assuming they are cleared by circuit breakers, is mainly interruption of service.

The gas evolution accompanying arc-back, if excessive, may delay resumption of service until the pumps can restore the necessary vacuum. Fast pumps and

From "Mercury Arc Rectifier Research," (No. 31-49) presented at the winter convention of the A. I. E. E., New York, N. Y., January 26-30, 1931.

well-degassed anodes have reduced this time to the order of one minute, and experiments now in progress are expected to reduce it to one second or less.

Control of Mercury Vapor Pressure

The most important single factor in mercury arc rectifier operation is the control of the mercury vapor pressure. This pressure depends on the temperature of the cooling water. The problem for investigation divides itself into two parts: (*a*) Assuming that the cooling-water temperature is uniform, what is the best temperature, and what are the permissible temperature limits? (*b*) If the water is not uniform, in what parts of the rectifier should the temperature be controlled?

The optimum temperature may be determined empirically by gradually increasing the load current at a given water temperature until a limiting temperature is reached, above which the rectifier will not operate at any load. Uniform temperature of the cooling water is maintained by rapid circulation. In this way a load-temperature curve is obtained, as shown in Fig. 2. The ordinates represent the maximum safe load for reliable short-time operation at each temperature. The important fact to be noted is that, while operation is possible at any temperature below a definite maximum, the load that can be carried is small at low temperatures and increases uniformly with temperature. The best operating temperature therefore is as near the maximum as can safely be maintained; and for a given load there is a definite operating range of temperature. For example, for the rectifier represented in Fig. 2, the operating range for a load of 1,500 amperes is between 42 and 60 deg. cent., as indicated by the shaded area. It is seen that there are two limitations to the range of reliable operation at a given voltage. One is high temperature, *i. e.*, high vapor pressure of mercury; the other is high current.

The maximum vapor pressure for a given operating voltage may be expected to follow closely the relation between vapor pressure and sparking potential; in fact, the only difference to be expected between arc-back potential and sparking potential is the change in the surface condition of the negative electrode, due to the presence in and just below the surface of gas molecules which have penetrated the surface in the form of positive ions. Such a composite surface is known to emit electrons more easily than a pure metal surface, and may be expected to allow a spark discharge at lower voltage. Hence the arc-back voltage should be very close to the sparking potential between electrodes of low electron work-function.

This conclusion appears to be justified by the results of a large number of tests made of sparking potentials. Typical results are shown in Fig. 3 which gives the sparking potential of an idle iron anode in a rectifier having 15-cm. diameter arms, with and without current to an adjacent anode. It is seen that the presence of ions due to current in the adjacent arm lowered the sparking potential by 50 per cent for the same vapor

Improving the Mercury Arc Rectifier

SOME of the problems most important to the successful construction of mercury arc rectifiers are discussed on these and the following nine pages. The first article, that by Hull and Brown, is a general treatment of the research problems which are being encountered in improving such rectifiers. Investigations are described of the three factors which the authors believe to be most fundamental; namely, vapor pressure, arc drop, and geometry of the anode housing. The second article, by Slepian and Ludwig, is concerned principally with the cause and occurrence of backfire in mercury-arc rectifiers, together with possible means for reducing the frequency of its occurrence. The authors point out that the random nature of backfire is not always appreciated, but that an understanding of this characteristic is essential to its elimination. The third article, by DeBlieux, is concerned with the losses in transformers for use with mercury-arc rectifiers, and introduces methods of calculating and testing the losses in these transformers independent of the rectifiers.

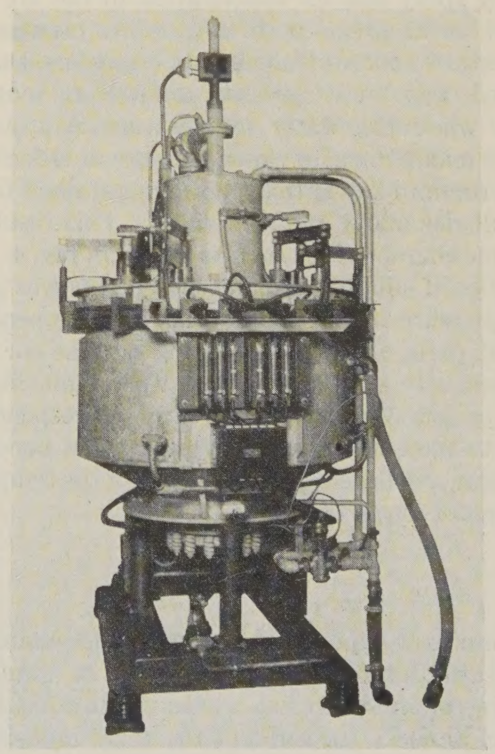

Fig. 1. Rectifier of recent design, with graphite anodes, subdividing grilles, and control grids

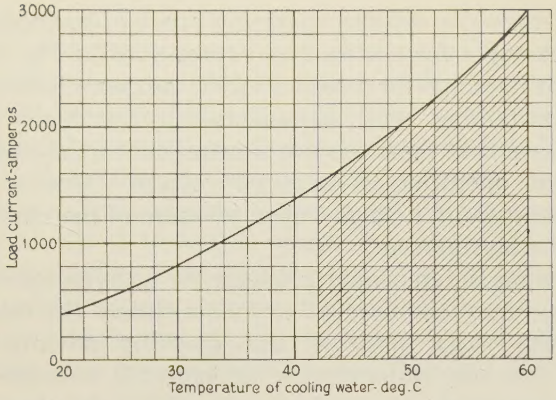

Fig. 2. Load-temperature curve for loads of 1 min. duration at 3,000 volts on a six-anode rectifier similar to Fig. 1, with 15-cm. diameter arms

pressure; or, conversely, lowered the vapor pressure for the same sparking potential by 50 per cent. Vapor pressure doubles for each 10 deg. temperature.

The current limitation is of a different nature. It is due to a complete utilization of the mercury vapor in the anode arms, the maximum load current being that which utilizes all the molecules of the vapor as positive ions to neutralize the electron space charge.

The vapor pressure in the anode arms is not completely determined by the temperature of the cooling water in the case of continued heavy loads, because of the temperature gradient in the iron wall and the iron-water boundary, and under some conditions, a pressure gradient in the mercury vapor due to convection of mercury spray and its vaporization in the arc stream. Differences as great at 10 deg. cent. between water temperature and equivalent vapor pressure have been observed and even greater differences may exist. Hence, when the water temperature is adjusted to give the maximum safe vapor pressure in order to carry the maximum load, if this load is maintained the pressure will rise above the safe value. This results in a load-time characteristic such as shown in Fig. 4.

A series of simultaneous measurements was made of vapor pressure in the anode arms and temperature in different parts of the tank, during normal low-voltage operation. It was found that with light loads the vapor pressure in the anode arm corresponds very closely to the temperature of the part just beneath the anode arm, and is nearly independent of the temperature of the rest of the rectifier.

Anode Heaters

The limits of vapor pressure are almost certain to be momentarily exceeded if mercury in a liquid state comes in contact with hot anodes or any hot surfaces near the anodes. In some of the early models it was observed when they were opened that the anodes and their housings were thickly coated with small drops of mercury which had condensed as the rectifier cooled. These rectifiers were known to arc back frequently within the period between 20 min. and 2 hr. after starting, which was about the range of time required under vaying loads for the anodes and housings to become hot enough to vaporize mercury rapidly, and thus lead to excessive local pressure with resultant arc-back. Heaters were therefore installed in the anodes and housings at a temperature higher than the body of the rectifier, so that condensation could not occur. The result was the entire disappearance of the 20-min. to 2-hr. arc-backs, and, in fact, of nearly all arc-backs.

Voltage Drop

The pulse of a rectifier is the voltage drop between cathode and anode when the anode is positive. It is a

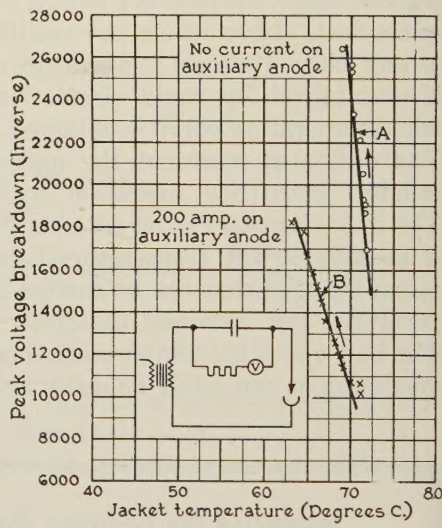

Fig. 3. Sparking potential of an idle anode in an iron-anode rectifier, as a function of mercury vapor pressure

valuable index of health, especially in studying or conditioning a new rectifier. For example, an exceptionally low voltage drop tells that the vapor pressure is abnormally high, and arc-back may be expected with continued load; a high voltage drop indicates excessive load, which must be reduced or the vapor pressure raised if reliable operation is to continue. If one anode has a higher voltage drop than the others it contains foreign gas, due either to leakage or incomplete exhaust; if lower, its grid has probably been injured during assembly or exhaust.

The slope or "resistance" of the voltage—current characteristic is negative for small currents, zero for moderate currents, and positive for large currents, as shown in Fig. 5. The negative portion of the characteristic is well known. The positive portion is observable only with low-pressure arcs, and is due to the approach to complete utilization of all the gas. When volt-ampere characteristics are obtained for different vapor pressures, it is found that the current at which the characteristic becomes positive is proportional to the vapor pressure, as may be seen in the figure. This is to be expected from the point of view previously expressed

that positive resistance is due to full utilization of the mercury vapor.

Using a peak-reading vacuum-tube voltmeter in a group of tests simulating operating conditions, it was found that arc-back usually occurs when the voltage drop exceeds about 50 volts. Hence the maximum load which a rectifier can carry may be predicted from the intersection of its volt-ampere characteristic with the 50-volt line. Excessive voltage drop is usually accompanied by surges which excite oscillations of the transformer system, sometimes of sufficient voltage to arc over insulation.

If the positive resistance shown in Fig. 5 represents a true instantaneous characteristic of the arc, it should be possible to operate such arcs in multiple for large currents without the use of stabilizing resistance or reactance. This was tested in a 24-anode rectifier, the anodes of which were arranged in two concentric rings of twelve each and connected in pairs to the terminals of a twelve-phase transformer, each pair consisting of one anode of the outer group and one of the inner group. The length of the arc path to the outer anode was sufficiently longer than that to the inner anode that an unfavorable condition for division of current existed.

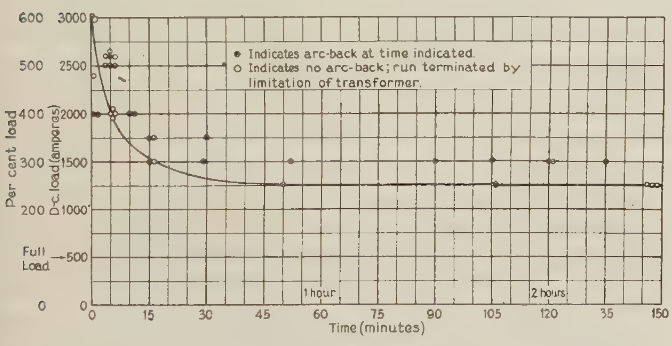

Fig. 4. Arc-back characteristic of same rectifier as in Fig. 3, at 3,000 volts and 60 deg.

From the characteristic given in Fig. 5 we should expect one anode of each pair to carry all the current for light loads for which the characteristic is negative, and for a small portion of the positive range, up to the current value at which the voltage drop is equal to the voltage drop for zero current of the other anode of the pair; at loads greater than this, both anodes of each pair will carry current, and will carry it more and more equally as the load increases. The current actually observed for several pairs of anodes conforms completely to the values predicted from the characteristic arc-drop curve.

As additional evidence of the approximately equal division of current, the rectifier was tested for current-capacity, first with one set of anodes alone, and then with the two sets in parallel. It was found that the rectifier would carry twice as much current with the parallel anode connection as with either set of twelve anodes alone. Further readings taken with an oscillograph agree with the load-limit test in showing that the load capacity is doubled by doubling the number of anodes and using them in pairs, each pair being in multiple without stabilizing reactance.

Geometry of Anode Arms

Since as previously shown the temperatures that determine the current capacity are almost entirely those near the anode arms, it may be anticipated that the important dimensions will be those of the arms. This has been found to be true. It has been shown, however, that for geometrically similar plain cylindrical arms, the capacity is nearly independent of the dimensions of the arms. The reason that the current does not increase with diameter is that the maximum safe operating temperature decreases as the diameter of the arm increases. Thus the total amount of vapor in the arm, and hence the current capacity, should remain about constant in agreement with observation.

The behavior is very different when the anode arm is subdivided so as to be equivalent to a group of small arms. If the part of the arm just below the anode is divided by metal vanes into narrow parallel channels, the limiting vapor pressure is determined by the dimensions of these channels and their distance from the anode, and is independent of the diameter of the arm. Under these conditions the current capacity is proportional to the square of the diameter, that is to the cross section of the anode arm. This is shown in Fig. 6.

This agrees with the previously described test for parallel operation which indicates that if any number n of adjacent anodes are grouped in parallel as a unit, without stabilizing resistance or reactance, the current which they can carry safely is n times that of a single anode. The group of parallel-connected anodes may

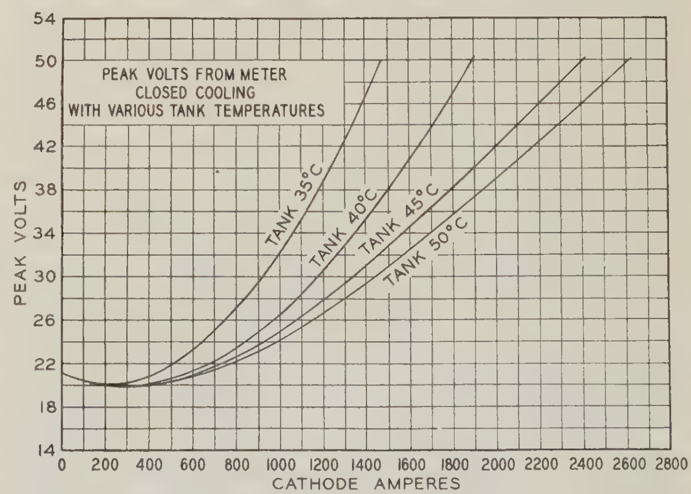

Fig. 5. Voltage drop in a mercury arc as a function of current

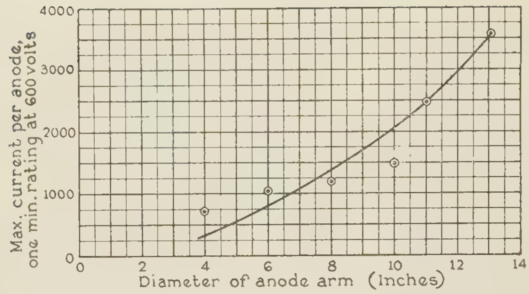

Fig. 6. Test points of current capacity for subdivided graphite arms. The solid line represents the theoretical limiting value of 4 amperes per sq. cm.

obviously be connected together inside the rectifier instead of outside, which is equivalent to combining them into one large anode with a number of parallel paths leading to it, each path similar in dimensions to one of the single anode arms. This is the principle of subdivided arms.

Their use has been very carefully tested, using partitions of different forms and dimensions, and anode arms from 15 to 33 cm. diameter. The results show that with a given "mesh" of subdividing partition, the current that can be carried is proportional to the total cross section of the arm, as it should be. The maximum operating vapor pressure, and hence the current per unit cross section, depend upon the dimensions of the partitions.

Grids and Their Uses

Grids or grilles consisting of parallel passages longer than they are wide may perform the function described above of enabling rectifiers to operate at a higher vapor pressure than is possible without these grilles. The sparking potential of a gas decreases with decreasing pressure, as is well known, to a minimum value, and then increases rapidly with further decrease of pressure. At pressures above that corresponding to the minimum, the sparking potential is higher the greater the distance.

The tungar rectifier operates above the minimum, *viz.*, at 5-cm. mercury pressure of argon. It might seem that advantage could be taken of this fact to increase the arc-back voltage of the tungar rectifier by increasing the distance between electrodes; for example, at 2-cm. distance the sparking potential is 1,800 volts. The answer is that it is impossible to maintain this distance under rectifying conditions, for the ionized gas that is left between the electrodes at the end of the rectifying cycle forms a conducting sheath around the positive electrode, building it out until its distance from the negative electrode is that corresponding to minimum sparking potential. This applies to all pressures higher than the "minimum" and all reasonable electrode distances.

It is evident therefore that high-voltage rectification can be accomplished, if at all, only in the range of pressure below the minimum point. In this range the sparking potential is higher the smaller the distance between electrodes. With an anode arm 30 cm. in diameter the effective sparking distance between anode and wall is of the order of 60 cm. At this distance the pressure of mercury vapor corresponding to a sparking potential of 6,000 volts is approximately 0.003 mm. The function of the grille is to decrease this distance and thus allow a higher operating pressure. For example, by placing a grille 5 cm. below the anode the distance is decreased from 60 cm. to 5 cm., and the pressure thus increased from 0.003 mm. to about 0.040 mm.

The form of the grid is important if it is to perform this function of shortening the distance between anode and body of the rectifier. Tests have shown that wire grids, unless their mesh is very fine, are not effective in shortening the distance, since the ions diffuse freely through the holes. On the other hand, partitioned passages or grilles like those described above do not allow ions to diffuse through, provided the length of the passages is large compared to their width.

Another use of the grid is to control the starting of an arc, rectifiers equipped with such grids being called thyratrons. Any type of grid can perform this function provided it is insulated, and the voltage that must be applied to it to allow or prevent starting of the arc depends upon its location and fineness.

One application of thyratrons is the use of the grid for obtaining automatic voltage regulation. The principle of this regulation is that the phase of the voltage applied to the grids is automatically advanced as the load increases. This is obtained by having the grid voltage derived from a current transformer in the line, so connected that its variable output voltage is added to a 90-deg. lagging constant voltage derived from a selsyn transformer. The constants are so adjusted that at light load the anode current starts late in the cycle, advancing with load until at the desired overload it starts at the earliest possible starting time, namely, the time at which the anode voltage rises above the rectified d-c. line voltage.

Hot-Cathode Rectifiers

Hot-cathode rectifiers, although not yet developed for large capacities, have many features which make them attractive. One of these is the ease of control of the mercury vapor pressures. A single drop of mercury suffices and this may be located in the coolest part of the tube remote from the arc so that the temperature of this part will determine completely the vapor pressure throughout the tube. The rest of the walls may be as hot as desired, thus permitting a considerable reduction in size of the rectifier.

Another advantage of hot-cathode rectifiers is low voltage drop with resulting efficiency at low operating

voltage. Three factors contribute to this low voltage drop. In the absence of mercury spray the distance between the cathode and anode may be short; an "efficient" cathode material, such as barium requiring but two watts per ampere, may be used; and a wide choice of gases is available. Thus hot-cathode rectifiers promise to fulfil the future requirements of low-voltage applications with an efficiency of 95 per cent or better at 250 volts, and well over 90 per cent at 100 volts.

Backfires in Mercury Rectifiers

Successful operation of mercury arc rectifiers requires the almost complete elimination of backfires. Studies made to eradicate this evil should recognize that backfires do not occur at some given stress, but are random in their nature. There is, however, an average rate of backfire which determines the reliability of a rectifier.

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In a mercury arc rectifier operating normally, each anode carries a large current when it is at a positive potential with respect to the cathode and a very small current (a few milliamperes) when it is at a considerable negative potential with respect to the cathode. It was found early that with the simplest and most obvious constructions this normal operation was not reliable, and was not reliable in an erratic way. An anode would function properly for perhaps thousands of cycles, and then suddenly fail to hold voltage when negative in some particular half cycle. With the usual rectifier circuits, such failures result in a short circuit and they are termed "arc backs" or "backfires."

From "Backfires in Mercury Arc Rectifiers," (No. 31-132) to be presented at the A. I. E. E. South West District meeting, Kansas City, Mo., Oct. 22-24, 1931.

The causes of these backfires are still not well understood, but it was found early that certain constructions reduced the likelihood of their occurrence. For example, cooling of the rectifier by introducing condensing chambers, water jackets, etc., keeps the vapor pressure low and reduces the backfire frequency. Also, moving the anodes away from above the cathode, placing them in shields, and placing grids in these shields such that they were interposed in the arc path, aided in reducing the chances of backfire. However, these remedial measures greatly increased the size and cost of rectifiers; and increased their arc drop, thus decreasing the efficiency. Consequently the whole design of the present day rectifier is predicated on the reduction of backfire frequency, and the means employed result in a rectifier for 600-volt service which is nearly as expensive as a rotary converter, scarcely more efficient and probably still less reliable. Clearly, research devoted to advancing the application of mercury arc rectifiers must consist of a study of backfire which will yield means for reducing the tendency without losing the attractive features of mercury arc conversion.

Backfires—A Random Phenomenon

A striking feature of rectifier operation is the erratic manner in which backfires take place. Yet the great significance of this erratic behavior and its implications as to the operation which may be expected, do not seem to have been generally grasped. It is essential to recognize that except for backfires due to certain grosser causes, which will be mentioned later, backfires are inherently a random phenomenon in that they do not take place immediately when a definite limiting stress is reached, such as, for example, when some limit of current, voltage or vapor pressure is exceeded. Backfires occur in a random manner under all operating conditions, but with an average frequency which depends on the conditions of operation. Hence a backfire is very unlike the breakdown of a spark gap, which is certain to take place if the potential difference across the gap is increased beyond a definite value. Backfires do, however, resemble many other examples of random or inherently erratic phenomena well known in physics, such as the Brownian movement, the disintegration of radium, or the fluctuation in the density of a gas when sufficiently small volumes of the gas are considered, and like these phenomena, backfires probably depend for their occurrence upon aggregates involving relatively small numbers of atoms, molecules, ions or electrons.

The entirely random occurrence of backfires in time may be illustrated by Fig. 1, which was obtained with a small metal tank rectifier, with all controllable variables held as nearly constant as possible. The probability of backfire of a rectifier is a particular condition and during a short time interval Δt may be defined as follows. Imagine a large number of tests N, made with a rectifier under identical conditions, the

time duration of each test being the interval Δt. Suppose that backfires occur in a certain number of these tests n, but not in the others. Then $\frac{n}{N}$ will be the probability of having a backfire in the time interval Δt, and if we write $\frac{n}{N} = p\,\Delta t$, then p is the probability of backfire per unit time.

It can be demonstrated that if the probability of backfire remains constant, and if the time intervals between successive backfires are observed, then the proportion of these time intervals which is greater than a given time T is e^{-pT}. That is $\frac{m}{M} = e^{-pT}$, where m is the number of intervals greater than T in length, and M is the total number of intervals. This relation has been confirmed experimentally with a metal tank rectifier having a constant current arc going to one anode and a negative test voltage on the other, with the result shown in Fig. 2.

The state of a rectifier with respect to backfire is properly described when a mean frequency of occurrence of backfire is given. It cannot be described by saying that the rectifier is operating above or below backfire limits, inasmuch as there are no definite backfire limits. The mean frequency of backfire depends on the construction of the rectifier, and on the conditions under which it operates. There are probably no commercial rectifiers which have a mean backfire frequency of zero; but a mean frequency as small as once in a few years is of course low enough to give more than the degree of reliability satisfactory for operating purposes. The backfire frequency of successful rectifiers in the field seems to be of the order of several per year.

Testing of Rectifiers

Commercial tests on rectifiers are made to determine their quality, which must be found in terms of an average backfire rate. Since this rate is very low for commercial rectifiers, its determination by usual tests is practically impossible. For example, suppose that a large number of rectifiers were made with such uniformity that each had an average backfire rate of once per month. If they were tested by the manufacturer for one month, which is impractically long, the mathematical probability is that 37 per cent of the rectifiers would not backfire, another 37 per cent would backfire once, and only 26 per cent would backfire twice or more. Consequently such a test would not show the true reliability of the rectifiers.

The way out of this dilemma seems to be to test the rectifiers under abnormal conditions which would make the average backfire rate countable in a reasonable length of time and to have data which will permit extrapolation for determining the backfire rate under normal conditions. For example, if the dependence of backfire rate upon test voltage is well established for a given type of rectifier, the tests might be made at such overvoltage as will give a countable rate in one day. Extrapolation to normal voltage would then give the expected backfire rate under normal conditions.

The variation of backfire rate with voltage for a small two-anode metal tank rectifier is shown in Fig. 3. The average breakdown rate was found to vary exponentially with the voltage. Current of 48 amperes was kept flowing to one anode, and a negative voltage was continuously applied to the other, grid-glow tube relays being used to record the backfires automatically. Tests were made at various times, and because of day to day variation as the quality of the rectifier changed somewhat for unknown reasons, different straight lines were obtained. All the data lay between the dotted lines shown in the figure.

Both iron and graphite anodes are extensively used by rectifier manufacturers. Tests at abnormal voltages on the relative average backfire rates with these two materials have shown that a few more backfires occur in a given time with iron than with graphite, but the

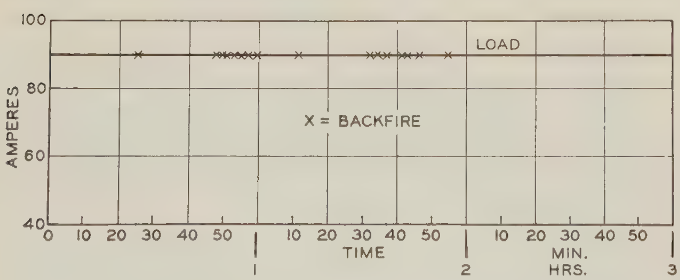

Fig. 1. (Above) Random occurrence of backfire on a small metal tank rectifier

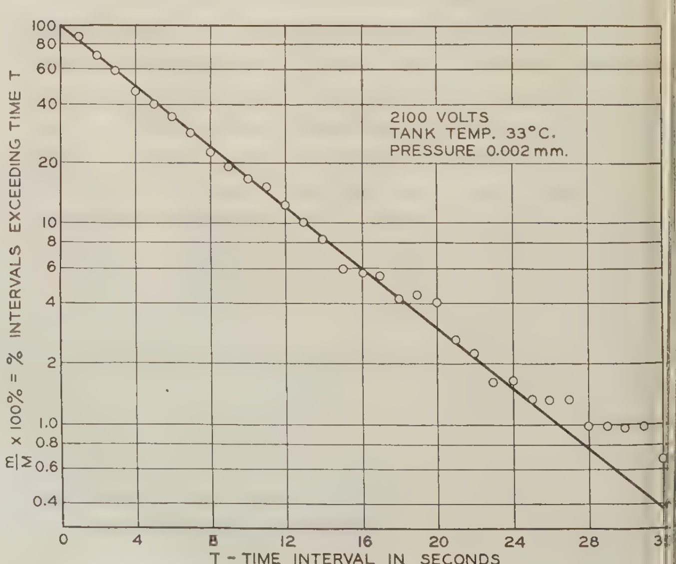

Fig. 2. (Right) Percentage of intervals between backfires exceeding time length T, in terms of time T

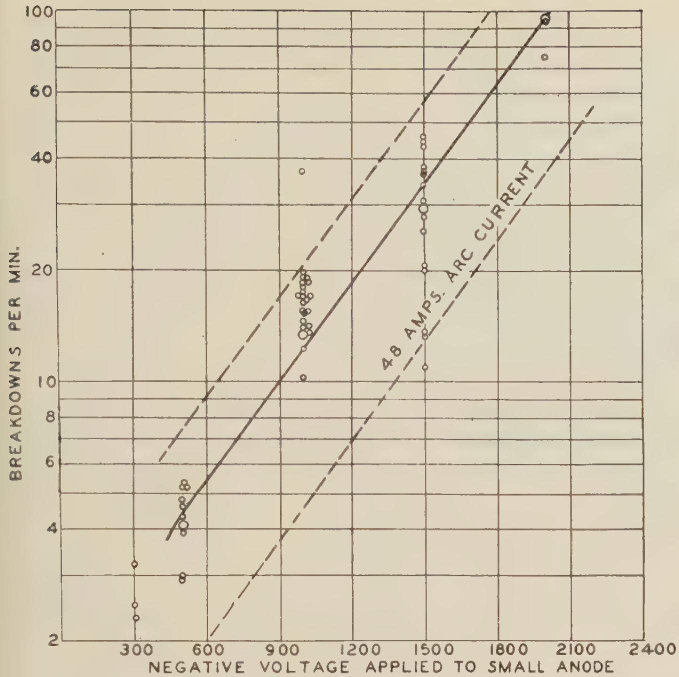

Fig. 3. Variation in average backfire rate with voltage for a metal tank rectifier

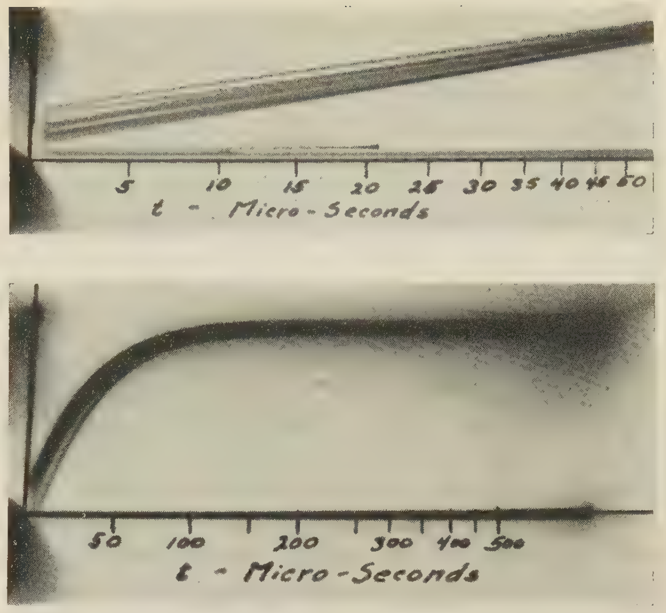

Fig. 4. Typical cathode-ray oscillograms showing time duration of backfire causes

difference is no greater than day to day variations with either material. Consequently, no decided advantage of either material is indicated from a standpoint of backfire rate alone.

Causes of Backfires

In addition to random backfires, certain grosser backfire causes which will not be random may occur in practical rectifiers. An example is the starting of an arc due to the blowing up of a conducting deposit formed over an insulator from anode to tank, the action being similar to that of a fuse. Direct observation shows, however, that such grosser causes are avoided in well-built rectifiers and that most backfires occur directly on the anode surface. It is these latter backfires, which are of the random type, to which we wish to give further consideration.

According to present available theories of the cathode of an arc, backfire should never occur without some initiating circumstance foreign to the kind of discharge taking place just previous to the backfire. A glow differs from an arc in that it requires several hundred volts at the cathode for its maintenance. In rectifiers, the construction and vapor pressure are generally such that it is not possible to hold a self-maintaining glow with the available negative voltage which is impressed on the anode. However, with normal negative voltage on one anode and an arc playing to the other, current flows to the negative anode which does not differ essentially from a glow, except that it is not self-maintaining. Consequently both the glow and the non-self-maintaining discharge will be considered together as the back current discharge.

A backfire consists in the sudden substitution of an arc for the normal back current discharge. Somehow, the conditions for the maintenance of the cathode of an arc must suddenly set themselves up. The conditions required at the cathode of an arc as predicted by present theory are such as should not occur spontaneously so far as the intrinsic characteristics of the back current discharge go. The conditions required at the cathode of an arc, according to present theories, call for either a very high temperature or a high current density.

With the low current density in the back current discharge, it is not possible to obtain sufficiently high temperature to produce an arc so long as the current is uniformly distributed over the anode. A sufficiently intense field at the cathode surface (10^6 volts per cm. or more) could initiate the cathode of an arc, but due to the high concentration of positive ions necessary such a field would require a current density of several thousand amperes per square centimeter. The current density in the back current discharge is only a few microamperes per square centimeter. The variation of current density over a very small area of surface might allow sufficiently high instantaneous densities, but such small areas must not be considered because the cathode of an arc is unstable if the current to it is less than 0.05 amperes.

Scrutiny of the back current discharge through the spectacles of present theories of the cathode of an arc fails to reveal the causes of backfire, provided the cathode surface be regarded as homogeneous. We must then consider the result of possible contaminations on the surface and flaws in the electrode material.

One type of backfire cause is suggested by tests made with a tube containing two graphite electrodes and equipped so that a small insulated tungsten wire could

be caused to make or break contact with the cathode. Voltage was applied to the electrodes of the tube and when it was sufficient to form a stable glow, backfires could be produced by making or breaking contact on the cathode with the small insulated tungsten tip. The cause of the backfire is to be sought in the very high current density at the lost contact point. This very high density will result as the area common to the point and electrode shrinks to zero during separation.

Several backfire causes may now be given. A very obvious one is contacting mercury drops thrown from the cathode. Small conducting particles such as iron rust or scale may contact with the anode and cause backfire in the same way, and in this an argument for extreme cleanliness in rectifier assembly is found.

Particles may detach themselves from the anode itself. It is well known that the anode suffers a slow disintegration known as sputtering, due to the back current discharge. Although the sputtered particles may consist largely of individual molecules, it is believed that larger particles are also detached. The presence of impurities would tend to cause a more frequent detachment of larger particles.

From this discussion on possible backfire causes it would be expected that the magnitude of the back current is important. If the back current is large, then the particle size necessary to cause backfire may be smaller. Also, the sputtering of the electrode will be more rapid with a large back current, and large particles are more likely to be detached or loosened. Any means which reduce the back current to the electrode, such as grids, shields, etc., must also reduce the frequency of occurrence of backfire. Experience shows this to be the case.

Another cause of backfire suggested by Langmuir is the formation of insulating patches on the electrode with dielectric failure of the patch as it becomes charged by back current. These patches are made up of impurities, oxides, or what not, and because of the small amount of material in their make-up their development to large sizes will be a random occurrence. Other experimenters also have surmised the existence of such insulating layers.

Duration of Backfire Causes

The random manner of occurrence of backfire as well as considerations of the preceding section make us believe that backfire causes involve only a small amount of matter. Since the amount of matter involved is very small, we should expect also that the time involved by backfire cause would be very small.

Cathode-ray oscillograph tests have been made to determine the time duration of backfire causes. A small metal tank rectifier was used, and continuous current was run to one anode and continuous negative voltage was applied to the other. A high resistance was placed in series with this anode so that in the advent of a backfire to it, a current too low for maintaining the cathode of an arc would flow. The cathode-ray oscillograph had a Norinder relay which was actuated by the backfire, and the voltage between tested anode and cathode was applied to the deflecting plates, typical oscillograms being shown in Fig. 4. The initial drop in voltage on the occurrence of a backfire does not appear because of a time-lag of three microseconds in the action of the Norinder relay. The time during which the voltage is very low is the time duration of the backfire cause. The finite rate of recovery of voltage after the backfire is due to electrostatic capacity of the potentiometer by which the oscillograph was connected to the rectifier. The duration of the backfire causes was usually less than five microseconds.

Losses in Mercury Rectifier Transformers

Improved methods of calculating and testing the losses in transformers for use with mercury arc rectifiers are now available. These methods greatly simplify the mathematics involved in loss calculations and make it possible to measure directly the losses of transformers independent of the rectifiers.

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DETERMINATION of the losses in transformers connected for use with mercury arc rectifiers involves difficulties not present in usual power transformers, due largely to the shape of the secondary current wave delivered to the rectifier. In the past, various tables have been published which give calculations of effective values of current and the losses in transformers in various rectifier connections. These calculations are based on the assumption that

From "Losses in Transformers for Use with Mercury Arc Rectifiers," (No. 31-70) presented at the North Eastern District meeting of the A. I. E. E., Rochester, N. Y., April 29-May 2, 1931.

the secondary current waves are rectangular in shape and that the effective resistance of the transformer windings is the same at all frequencies. However, calculations based on these assumptions may be considerably in error as the current wave contains a large number of harmonics which are influenced somewhat by the reactance of the circuits, and the effective resistance of transformer windings varies with the frequency. Using the d-c. resistance of the windings and the theoretical values of the harmonics as explained below, much more accurate calculations of transformer losses result.

A rectangular secondary current wave can be analyzed into a series of terms in which the amplitude of the nth harmonic is:

$$A_n = \frac{2\,J}{n\,\pi} \times \sin \frac{n\,\pi}{P} \qquad (1)$$

in which J = magnitude of direct current

P = number of phases

The effect of the reactance of the circuit is to alter the assumed rectangular wave shape by sloping the sides of the wave, as a definite time is required for the current to rise to its full value at the beginning of the conduction period and fall to zero at the end. The effect is to reduce the magnitude of the harmonics in the current wave.

A formula has been developed for calculating the effective winding resistance in which

$$\text{Watts eddy current loss} = 0.86\ Y\ X^{1.875} \qquad (2)$$

where

X = frequency

Y = the sum of the other factors which determine the eddy loss, and is constant for a given winding

The actual magnitude of the various harmonics in the primary and secondary current waves of a representative six-phase rectifier connection was measured, and from these readings and the corresponding winding resistances, the losses were calculated and found to be the same as would be obtained in the d-c. resistance of the windings, and the theoretical values of the harmonics as determined from equation (**1**) were used to determine the losses. This indicates that for the average circuit, the effect on the losses of the increase in resistance at the harmonic frequencies is approximately balanced by the effect of the reduction in magnitude of the harmonics due to the reactance of the circuits. These results hold with satisfactory accuracy for the other commonly used rectifier circuits.

The calculation of losses based on the d-c. resistance of the transformer windings and the theoretical values of current harmonics for rectangular secondary current waves has been recommended for the proposed A. I. E. E. Standards for Mercury Arc Rectifiers. This method eliminates involved mathematical calculations and factors based on design features. Also, the calculations may be checked by the purchaser and used to determine the safe size of cables for making connections.

Testing Methods

Three methods of testing are proposed for the three classes into which all of the commonly used rectifier connections fall. For all tests, rated sinusoidal current at rated frequency is held in the primary, and the secondary windings are short-circuited as follows for the various types of connections.

The six-phase multiple wye secondary connection of transformers is shown in Fig. 1. For this type of connection, the copper losses measured with one-half of the secondary windings of each phase short-circuited,

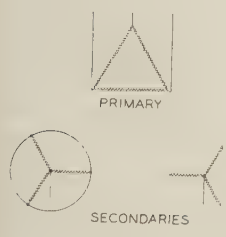

Fig. 1. Test connections for six-phase multiple wye transformers

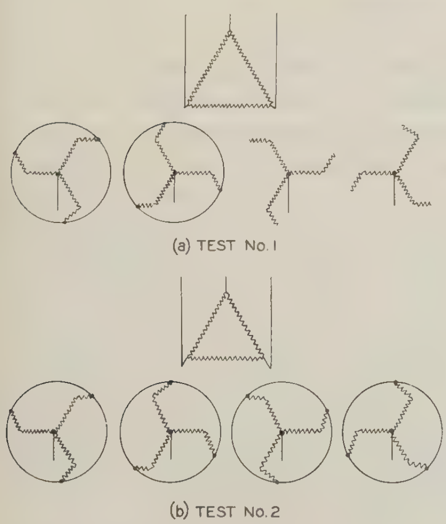

Fig. 2. (Left) Test connections for twelve-phase multiple wye transformers

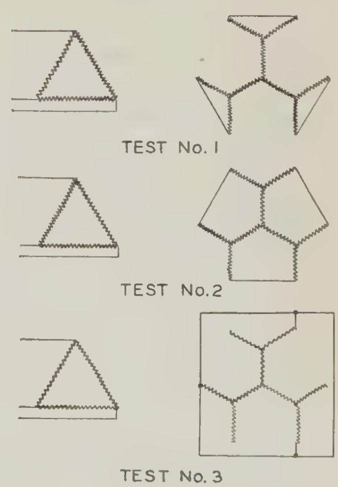

Fig. 3. (Right) Test connections for six-phase forked wye transformers

as indicated by the straight lines, equal the loss which would be obtained under rectifier operation.

For the twelve-phase multiple wye connection, two tests are made. The first is with one-half of the secondary coils of each phase short-circuited as shown in Fig. 2(**a**), and the second is with all of the secondary coils short-circuited as shown in Fig. 2(**b**). Denoting the losses measured in the two tests by L_1 and L_2 respectively, the copper losses which would be obtained under rectifier operation will be:

$$W_{cu} = 1.12\,L_1 - 0.12\,L_2 \tag{3}$$

For six-phase forked connections, three loss measurements are made with the secondary winding short-circuited as shown in Fig. 3. Denoting the loss measurements for the three tests by L_1, L_2, and L_3 respectively, the copper losses which would be obtained under rectifier operation will be:

$$W_{cu} = \frac{L_1 + 2\,L_2 + 3\,L_3}{6} \tag{4}$$

Since the voltage wave impressed on the transformer primary approximates a sine wave when the rectifier is fed from a system whose capacity is reasonably large, the iron loss should be measured in the same manner as for ordinary power transformers. It is therefore possible to test the main transformers of the various rectifier connections independently of the rectifiers, and determine with satisfactory accuracy, the losses in both copper and iron which would be obtained under rectifier operation.

Corona and Line Surges

Tests on an experimental transmission line show that from the standpoint of damping transient surges there is no advantage in operating the line at so high a voltage that the conductors will be in corona.

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FREQUENTLY in technical literature the suggestion has been made that power-frequency corona would increase the damping of transmission-line surges. A recent repetition of this ideal, all unsubstantiated, led to the present investigation the results of which have shown that the presence of corona is of no value in this connection; its damping effect in any case is only slight and often is more harmful than helpful.

A surge on a line in service, if due to lightning, may have a voltage far exceeding the corona-forming voltage of the line; in such a case the chief attenuation will be due to corona. To explain further, the surge itself will ionize the air around the conductor and in so doing, the energy stored in the surge will diminish; the maximum voltage of the surge will decrease accordingly. Ionization will continue as the surge travels along the line as long as the voltage of the surge is above the corona limit; thereafter attenuation will be much slower, for the main damping influence will have lost its effect. This ionization is a real phenomenon, since the corona produced by a single impulse of extremely short duration may be seen clearly in the dark, and the noise that a surge makes as it passes may be heard quite as easily.

It is evident that a previous condition of ionization about the conductor due to overstress at power frequency would affect the rate of loss of energy from the impulse; but in what way may be found only by experiment. To determine the nature of this relationship, therefore, this investigation was undertaken.

Test Equipment

Apparatus was devised by which traveling impulses with crests as high as 440-kv. could be sent along a 1,000-ft. line. For furnishing these high-voltage impulses, an adaptation of the "lightning generator" was used. A condenser charged by power-frequency current had its energy suddenly released by the breakdown of a sphere-gap, and as fast as the inductance of the condenser circuit permitted, the condenser voltage appeared between the sending end of the transmission line and ground. This voltage and current proportional to it sent along the line a wave the magnitude of which was increased with time, until a sphere-gap at the sending end of the line sparked to ground; the sending voltage then fell to zero almost immediately and remained negligible thereafter while the wave traveled out along the line and was measured. Ordinarily, the trip-gap was set to discharge the condenser at 375 kv. It was found convenient to chop the impulse by means of the

Written specially for Electrical Engineering. Not published in pamphlet form.

gap at the sending end of the line at some value between 100 and 200 kv. The time required to build up such a voltage was about 0.05 microsec. The critical corona voltage of this 1,000-ft. line at 60 cycles was found to be about 30 kv. or 43 kv., crest value.

Voltages were measured at each end of the line and at several intermediate points by means of sphere-gaps. If the observer were far enough from the noise of the laboratory, an interesting supplementary comparison of impulse voltages was possible by listening to the sound that accompanied impulses of voltage higher than the critical corona value. A click somewhat like the noise made by dropping a pencil indicated that a wave had passed, and in passing had ionized the air; a second or so later would come the crash of the sphere-gaps in the laboratory; and perhaps between the two, the snap of the measuring sphere-gap. On a bright day the ear was more to be trusted than the eye in reporting events.

The rapid attenuation of surges when their voltages were higher than the corona-forming voltage of the line, and their slower attenuation near that voltage, is shown graphically in Fig. 1. The most evident disclosure of these curves is that the impulses, at whatever voltage they may be sent, are rapidly cut to a crest value between 25 and 50 kv. Thereafter attenuation is so slow that at the terminus of the 1,000-ft. line, it is difficult to distinguish between a wave that started with a crest of less than 100 kv. and another that started at more than 200 kv.

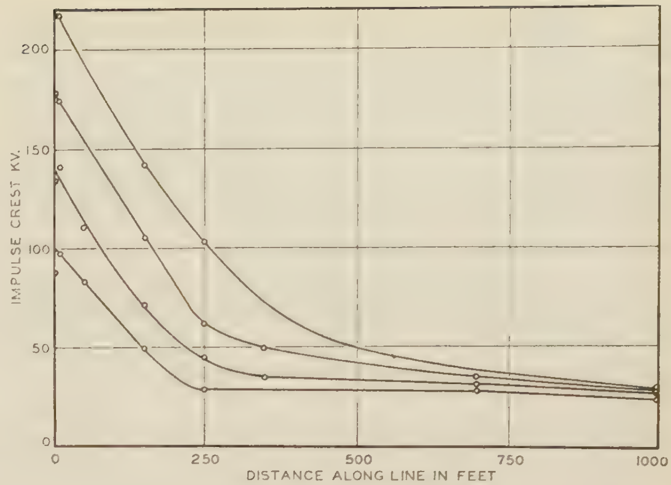

Fig. 1. Attenuation of transmission line surges. Note rapid reduction above the corona-forming voltage (30 kv.)

Surges Superposed on Different 60-Cycle Line Voltages

When the action of the impulses was moderately well understood and the technique of measurement was developed sufficiently to give assurance of significant results, the line was tested while in corona. The apparatus permitted the impulse voltage to be superposed suddenly on a steady 60-cycle voltage. The phase of the corona-voltage cycle at which the impulse was applied was definitely known, and in the first work the impulse "struck" at the instant of maximum 60-cycle voltage. The sending-end sphere-gap now did not measure the impulse voltage alone, but the sum of impulse and 60-cycle voltages, added when the polarities were the same and subtracted when they were opposite. The same is true of the measuring sphere-gap at intermediate points on the line.

These combined impulse and line-voltage measurements represent the values in which the engineer is interested, since the strongest impulse that may be propagated over a line is one which will not flash across a string of insulators when added to the line potential at that instant. Whether or not a surge still will be dangerous at some crucial point, as, for instance, at a transformer bank, depends upon whether at that point the insulation will fail under the combined action of normal line and impulse voltages. Hence, while the sphere-gap does not measure the impulse voltage directly, it does give an indication of danger. At the end of the line, reflection of the impulse adds to the danger; the resultant crest voltage at the terminus may be found by a simple computation, or it may be measured directly.

The presence of corona was found to make a measurable difference in the behavior of the high-voltage impulses. When the impulse was thrown on the line with the same polarity as the 60-cycle voltage, the rate of attenuation of the impulse was lessened to a marked degree, and the danger at any point was correspondingly great. When polarities were opposite, the 60-cycle voltage had less total effect; attenuation of the impulse was more rapid, which lessened the danger at any point along the line, but the danger due to reflection at the terminus was much greater.

The foregoing effects are shown in Fig. 2, where the crest voltage of a given impulse after traveling a certain distance is shown as a function of the 60-cycle line voltage. The lower pair of curves intersects the axis at a value corresponding to the 150-ft. point on the 133-kv. curve of Fig. 1. In like manner, the upper curves intersect the axis at a value corresponding to the 50-ft. point. These points on the two figures must therefore indicate the same impulse crest because they represent identical conditions. For the other points of Fig. 2 the impulse was superposed upon different 60-cycle line voltages. Points determined when the impulse and 60-cycle voltages were of the same polarity are marked with "plus" signs; points representing opposite polarity are indicated by "minus" signs.

Surges Applied in Different Phase Relations

Apparently, attenuation of the impulse is not altered by line voltage unless the line voltage is high enough to produce corona, although this cannot be proved; how-

ever, the belief is supported by other tests in which the impulse was applied in various phase relations with respect to the corona-voltage cycle. With 40 kv. at 60 cycles applied, and with the gap at the sending end of the line retaining a fixed spacing, the moment of applying the impulse was shifted by 60-deg. steps. With the sending-end sphere-gap setting the same as used in obtaining the data for Fig. 2 (to give an impulse of 133 kv.) the impulse crest voltage without 60-cycle line voltage was measured at a distance of 150 ft. from the sending end; then 40 kv. was applied and the impulse was impressed at the same instant at which the

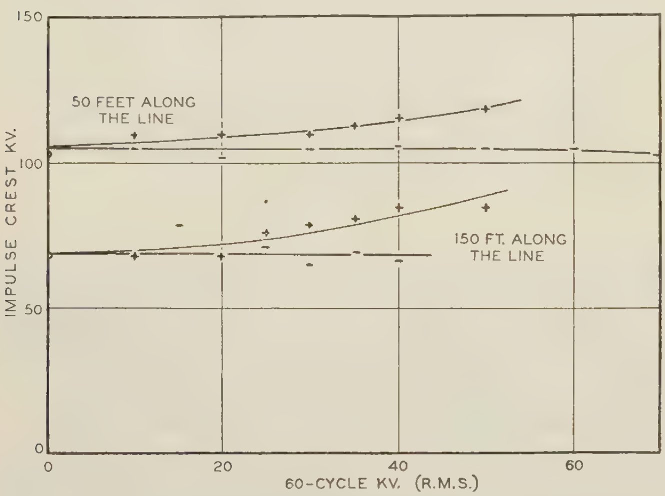

Fig. 2. Effect of different line voltages upon attenuation of 133-kv. surges

+ indicates surge and line voltage of same polarity
− indicates surge and line voltage of opposite polarity

60-cycle voltage reached a maximum of the same polarity. These measurements were followed by another with two voltages of opposite polarity. These are shown in Fig. 3, the radius of the circle being a measure of the impulse voltage alone; the vector drawn upward (83 kv.) indicates the resultant impulse voltage when the polarities were the same, while the vector pointing downward (62 kv.) gives the resultant voltage when polarities were opposite. Similar measurements were made with the impulse applied 60 and 120 deg., respectively, after maximum line voltage first with one polarity and then with the opposite. Results of these tests are indicated also in Fig. 3.

For the first two cases (impulse voltage superposed upon a 60-cycle maximum of the same polarity and of opposite polarity, respectively) the expected change in rate of attenuation was observed; for the four intermediate phase positions there was no significant difference from attenuation without 60-cycle voltage.

Test Results Analyzed

Space charge about the conductor when in corona seems to play an important role in aiding or impeding the attenuation of impulses. That the chief attenuation of the impulse is due to ionization is evident because (1) the impulse may be seen and heard and so must dissipate energy; (and 2) attenuation is rapid above the corona-forming voltage and slow below it. If 40-kv. power-frequency voltage be applied to a line that permits corona at 30 kv., there will be a zone about the conductor in which the potential gradient is the critical gradient of air (about 30 kv. per cm.); the gradient cannot be greater because air under a greater stress would ionize until the resulting space charge reduced the gradient to the critical value. (Since the times involved in 60-cycle changes of current and voltage are so vast compared to impulse times, the 60-cycle conditions existing at any moment may be considered fixed.) This cushioning action of the space charge makes possible the maintenance of a line voltage greater than the corona-forming voltage, for without such protection the air would continue to be broken down as fast as ionization by collision could take place; and were this the case, no reasonable amount of power could sustain a voltage substantially above that at which corona first appeared.

In the light of the foregoing, if an impulse voltage of the same polarity as the 60-cycle line voltage should occur, and if the 60-cycle voltage already has produced corona and hence protected itself by forming a space charge, it will be impossible for the impulse to attenuate by ionization to a voltage below the 60-cycle value. The cushioning effect that protects the 60-cycle voltage also will protect the impulse voltage. This is doubtless the reason that as soon as corona appears about the line, impulses are found to be attenuated more slowly if they are of the polarity of the line voltage. If they are of the opposite polarity, the space charge has the contrary effect; instead of lessening the gradient in the neighborhood of the wire as the impulse passes, it increases it. Presence of the space charge increases the electric field and thereby increases the energy loss, thus increasing the attenuation.

Without more quantitative information about energy loss from impulse voltages, it is impossible to predict the comparative efficacies of a given intensity of corona toward decreasing and increasing the attenuation of surges of similar and of opposite polarities. In the latter case, however, as expected and shown experimentally, the potential due to space charge is a smaller fraction of the impulse potential and will have a correspondingly lesser effect.

The wave shape of the impulse, that is, the function of time which describes the voltage at a point, also will influence the rate of attenuation of the impulse crest. An impulse shorter than 1 microsec. is considered fast, but ionization by collision is tremendously faster; hence a protecting space charge will be built up by the impulse itself as it travels along the line. If the wave is not sharp-crested but has a flat top, the latter part of the wave will be protected by space charge formed at the expense of the part preceding. While all

of the wave eventually (if the line be long enough) will become reduced to the corona-forming voltage of the line, the front of the wave will lose energy most rapidly at first, and the crest voltage will diminish more slowly. No such action is possible in the case of a short wave, which rises quickly to a crest and as quickly falls. Space charge of enough intensity to protect the maximum voltage is formed only by the peak itself, and the wave immediately passes on to less ionized and unprotected sections. A long, flat wave, then, is less rapidly attenuated, and therefore is more dangerous than a short, sharp wave.

Conclusions

Work on attenuation of surges has been described in previous Institute publications (the most recent of these may be found in the July 1931 issue of ELECTRICAL ENGINEERING, pp. 478-502). Results of the present study are in such complete agreement with previous results that, for the most part, the conclusions reached may be quoted from the summary of one of the earlier investigations of Conwell and Fortescue, (A. I. E. E. TRANS., July 1930, p. 872) whose experimental work is of great interest in the light of the theory here presented:

1. "Considering crest voltage of the original surge and its attenuation, the attenuation is increased with crest voltage over the length of line used. The rate of increase in attenuation is much more rapid when the surge voltage exceeds the corona point of the line.

2. "Considering the relation between the length of wave and its attenuation, the short wave attenuates more rapidly than a long wave of equal crest voltage.

3. "Considering the effect of distance traveled on wave shape, with increased distance there seems to be an increased tendency to slope off the front of the wave and to increase the length of the tail. This change in form is more accentuated above the corona point."

To these now may be added another:

4. Considering the effect of power-frequency corona about the line, it will retard the attenuation of a surge of its own polarity, but will have little effect on a surge of opposite polarity.

The amount of attenuation is of great practical interest and there may be significance in a comparison of present results with those of Lee on the Wallenpaupack-Siegfried line. (TRANS. A. I. E. E., Vol. 48, p. 471.)

The line considered as the basis of this article was similar to the line considered by Lee, but reduced to one-tenth size; that is, the conductor considered in this article was about 10 per cent of the diameter of his and displayed corona at 28 kv. (r. m. s.) instead of at about 280 kv. The surges used were near 220 kv. while the lightning surge recorded on Lee's line started at 2,230 kv.

In becoming proportionately attenuated, his surge traveled 100 times as far as those mentioned in this article, or in the ratio of 10^2. These ratios were used in making up Table I: voltages of the line considered in this article are multiplied by 10; the distances by 100.

Included in the tabulation is a set of computed voltages that result from assuming that the energy lost (as the surge travels) is proportional to the voltage of the surge. This assumption is arbitrary, but agrees impressively with Lee's results and with those of this article as shown in the four curves, Fig. 1. Since energy is proportional to the square of voltage,

$$\frac{d}{d\,x} E^2 = -\,k\,(E - e)$$

where E is surge voltage, e is corona-forming voltage,

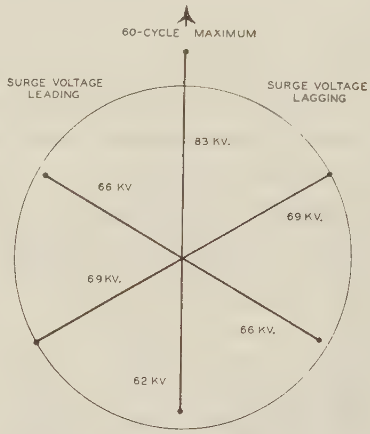

Fig. 3. Diagram showing surge-voltage measurements 150 ft. along the line with 133-kv. impulses applied in different phase relations with respect to the 60-cycle, 40-kv., line voltage

Radius of circle (68 kv.) indicates surge measurement with zero line voltage; arrow at top shows "in phase" position

k is an experimental constant, and x is distance along the line. The solution is

$$x = m\,[n - (E + e \log_{\epsilon} (E - e))\,]$$

where m and n are constants involving k and the initial voltage. The computed voltages fit nicely into the tabulation, and differences can be explained as experimental error, line resistance, and (most important) change of wave-shape as the impulse travels.

These results imply that the "effective range" of a lightning surge is nearly proportional to the voltage of the surge, and to the corona-forming voltage of the line.

Table I—Comparative Surge Attenuation Data

Distance miles	0	5	10	15
Kilovolts				
Computed	2,230	1,180	560	410
Lee	2,230	1,080	680	320
Skilling	2,250	1,000	480	380

Dr. Harris J. Ryan and Dr. Joseph Carroll by guidance and aid have made possible the study leading to this paper.

Communication Plays its Part in Electric Power System Operation

Present day electric power systems, with their complex and far-flung interconnections, cover such large areas that the communication lines serving them have become almost as important as the power lines themselves. In the five articles on this and the following nine pages fundamental requirements of the electric utilities are outlined, and the communication schemes used by four typical operating companies are described.

ELECTRIC LIGHT AND POWER in all its perfection is not entirely independent of several other agencies of public service. Not the least of these is communication, which makes the light and power system the living organism it really is. Because the electric power system is everywhere, far flung in supply centers and activities, it is more dependent upon communication in the discharge of its obligations than are most other forms of business. This agency serves to coordinate the widely separated elements and thus plays a big part in unifying the operation of electric power systems. This is a necessary adjunct to the provision of satisfactory service to customers; for although a properly designed and constructed system, adequate tools, and able personnel, all are essential, yet no adequate service is rendered, and hence no revenue earned, until these elements are coordinated and unified.

This group of five articles is based upon five papers presented as a symposium at a session of the Institute's 1931 summer convention. They were prepared jointly by a total of six engineers of leading power companies, in collaboration with three communication engineers of the Bell telephone system, and therefore represent the joint efforts of those engineers most intimately connected with the needs of a power system and those having the best knowledge of modern developments in the communication field.

All five articles stress the importance of providing efficient and uninterrupted communication facilities for operating personnel. In most cases these facilities are provided by networks of interconnected privately owned and Bell system lines, although in one case carrier current furnishes the principal communicating medium. One article deals with a joint study between telephone and power company engineers, when the entire communication system of the power company was overhauled thereby effecting many improvements. Another article of the group describes the special communication facilities arranged by one company for handling customers' calls. Still another narrates in some detail how a special remote-metering system was installed, by which means continuous and practically automatic direction of load-scheduling activities was achieved.

The first article, which outlines the power company's principal requirements and suggests methods for meeting them, follows immediately.

Underlying Considerations of the Problem Outlined

By

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EFFECTIVE COORDINATION of the activities of an electric utility necessitates the establishment of communication channels for the continuous flow of information into organization centers, and the prompt transmission of orders and suggestions from these centers to the points where action is taken. Voice communication appears to be especially adapted to meet these requirements, as is evidenced by the fact that about 85 per cent of the average electric utility's communication expense is for transmission of the spoken word.

From "Communication Services of Electric Utilities, Underlying Considerations" (No. 31-104) presented at the A. I. E. E. summer convention, Asheville, N. C., June 22-26, 1931.

The work of an electric utility may be considered as being divided into the following three general classes:

1. Operating activities including dispatching, generating and substation operation, emergency line patrolling and repairs.

2. Customer service activities embracing all contacts between the utility and its customers.

3. Administrative activities including administrative sales and business functions as differentiated from service functions.

Operating Activities

A typical organization chart for the handling of activities classed as "operation" is shown in Fig. 1. This indicates the communication channels usually necessary for the efficient flow of information between controlling centers and points where action originates. Communication facilities for such activities need to be:

1. Easy to operate and conveniently arranged.

2. Available at times when power facilities are in trouble.

3. Of such quality as to permit conversations to be carried on with ease.

4. Protected so as to be safe for use at all times including periods of system disturbances.

5. Of sufficient capacity so that under the *worst* emergency conditions no serious delays will be experienced in restoring electric service.

Heavy or important traffic requires the establishment of direct channels. Where continuous service must be provided, two or more independent paths are essential and these should be so routed that troubles on one will not affect the other.

Communication channels often are terminated at dispatching points in a cordless type of board where answering, ringing, and monitoring features are obtained by merely operating a key. This type of equipment appears to be suitable for use where no more than 50 channels are to be terminated, or where the required number of simultaneous through connections does not exceed five. Where more than these are involved, cord and plug boards usually are installed.

Teletypewriter apparatus is used to some extent in transmitting and recording routine information, such as meter readings and switching orders, and there is some probability that this equipment will provide a valuable supplement to the telephone in power-dispatching work.

Some electric utilities have considered it desirable to provide facilities for communication along the transmission line right-of-way. Both portable telephone equipment and permanent stations installed at convenient locations have been used for this purpose. The accessibility of the transmission line and the relative importance of maintaining uninterrupted power service over a particular route determines whether or not such facilities are necessary. Apparently each situation requires individual study to ascertain its particular requirements.

In effecting centralized control of a power system, the value of telemetering, remote indicating, and supervisory-control services is gaining rapid and wide recognition. Where long distances are involved, apparatus operated by direct current over separate channels or by means of impulses sent over narrow frequency channels appears to be the most economical. For shorter hauls, the cost of conductors usually is not prohibitive, and apparatus using separate wires for each metering or control service probably is the most economical and desirable. Since normally, large investments in power equipment are involved, and manual assistance cannot be obtained quickly at unattended stations, the conductors used for control purposes must give reliable service.

In some of the larger electric systems, arrangements are desired which will permit the sharing of frequency control by several generating plants, or possibly in the ultimate provide for station load distribution on an automatic basis in direct proportion to the relative costs of generation. In this connection it has been suggested that for the purpose of synchronizing frequency-controlling devices in generating plants, a constant-frequency supply might be furnished over communication channels. For this purpose, apparatus employing a quartz-crystal oscillator in conjunction with vacuum-tube circuits is available in laboratory form; a frequency stability of approximately one part in ten million or about three seconds in one year is provided. Tests to determine the value of this constant-frequency supply in electric utility operation are being considered.

Customer Service Activities

A vital factor in supplying satisfactory electric service is the provision of convenient means for the customer to convey to the utility company his impressions and

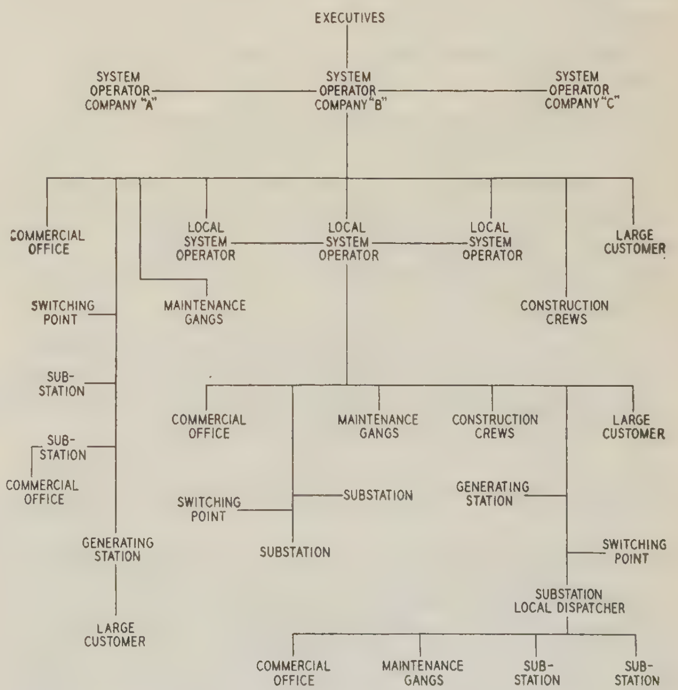

Fig. 1. Typical communication channels for operating activities of an electric utility

reactions regarding his electric service. Since a large majority of such contacts is made by telephone, electric utilities generally have recognized that customers calling by telephone should be handled as intelligently and as courteously as though calling in person.

Experience indicates the desirability of establishing an organization specially trained and assigned exclusively to dealing with customers over the telephone. Under this plan, direct observations can be made to determine which practises are most effective in building up good-will among the customers. Where centralized customer-service bureaus are established, communication channels are necessary between the bureau and the various departments in the company so that the attendants may obtain readily any information necessary for transacting business with customers. Usually the work of the bureau is simplified as much as possible; this may be done by providing a centralized file of customer records, by short-cut methods of handling customer orders, and by the convenient arrangement of telephone facilities.

Administrative Activities

Included in this group are executive, legal, engineering, and accounting matters together with certain features of operating work where speed of action is not the governing factor. The type and volume of administrative activity handled by telephone generally necessitates extensive circuit and equipment arrangements. These communication facilities usually are provided by the telephone companies. It is important that the electric utilities make their objectives clear so that the communication arrangements provided by the telephone companies will accomplish the desired results.

Essential requirements in communication channels for administrative traffic are no different than those for similar traffic in other lines of business. When the volume is sufficient, channels are leased for full-time use. Arrangements may be made with the telephone company also for short-period talking channels to be set up at certain specified hours of the day. Where traffic is light, ordinary public-message channels usually provide satisfactory service.

Where quick transmission of letters, orders, accounting matters, or other administrative affairs, is necessary, and a written record is desired, teletypewriter service has been found to be of particular value.

Methods of Providing Communication Channels

Cable and open wire. Most of the communication channels used by electric utilities consist of cable and open-wire lines. Cable is relatively free from trouble during storms and is considered a desirable type of facility while from the standpoint of service continuity, open-wire channels are somewhat less desirable. Where open-wire circuits only are in use, enough channels often are available over regular or alternate routes to insure the desired reliability. Where necessary, extra guying, short spacing of poles, and similar measures are employed to strengthen such lines. There seems to be a growing disinclination, however, to rely upon open-wire facilities routed along the same right-of-way with power lines on which service is to be protected.

Carrier-current telephone apparatus. In a number of instances during storm breaks, power-line carrier-current equipment has provided the only means of communication available, and it is considered generally to be a reliable form of service. There appears to be a definite but somewhat limited application for this type of communication over long hauls where generating plants and substations in remote and sparsely settled locations must be reached. In such situations the cost of providing suitable cable or open-wire facilities may be prohibitive.

Variation in quality and volume of transmission often is experienced with carrier current due to the fact that the characteristics of the power network used as the transmitting medium are affected by switching or circuit changes. Difficulty also has been experienced in connecting the apparatus to two-wire circuits. Opinions as to the value of this type of equipment differ, and in order to arrive at satisfactory conclusions regarding the extent to which it logically may be employed, further experience is necessary.

Radio. In providing back-up service for regular communication facilities some use has been made of radio, but the cost of securing the desired reliability and restrictions as to operation have prevented any extensive use of this type of communication.

Basic Communication Plan Needed

For most efficient results, maximum use should be made of all communication facilities, a satisfactory grade of service should be available for immediate use at the principal operating points, and future needs should be cared for slightly in advance of actual demand and without replacement of any large part of existing facilities. These objectives cannot be met economically without establishing a basic communication plan for the electric supply system as a whole, developed along consistent lines.

Extensive interchange of power between electric utilities and frequent consolidation of operating properties is emphasizing the need for some degree of uniformity in communication arrangements. Also traffic loads and operating contingencies usually can be cared for with a greater margin of safety and less expense where all telephone services and facilities are unified and operated as one system. Convenient switching arrangements accordingly have been developed to allow the operating department to seize quickly and hold any desired circuits for an indefinite period of time. These arrangements permit the exclusive use of circuits by the operating personnel whenever in their opinion

such use is necessary, and would seem to provide in effect the equivalent of an exclusive communication network.

In a number of instances studies have indicated that best results could be secured through the connection of the electric utility's privately owned communication system to the facilities furnished by the telephone company. Interconnections of this nature enable the electric utility to eliminate all useless duplication of circuits and equipment, to obtain a broader use of privately owned plant, and to retire such plant investment in an orderly fashion.

Growth of the electric utility industry is extremely rapid. Activities of operating companies are broadening in scope continually as the areas served increase in size and customer demands become heavier and more exacting. It is important that the activities of electric utilities be studied constantly to determine how communication facilities can be used to greater advantage and to anticipate requirements so that the necessary service will be available when required. Consideration along these lines will assist to a marked degree in the attainment of that which utilities are striving for—continual improvement in customer service.

Communication in the Niagara Hudson System

By
E. S. BUNDY
Member A. I. E. E.

Buffalo (N. Y.) Niagara & Eastern Power Corp.

THE WESTERN DIVISION of the Niagara Hudson System which serves an area in New York State approximately 250 mi. long and 100 mi. wide has developed a coordinated communication plan including both privately owned and leased lines supplemented by carrier current. In the development of this system, engineers of the New York Telephone Company have worked in cooperation with the power company's operating and executive staffs to develop a flexible, dependable, and adequate communication network.

One of the outstanding features of this system is the manner in which customer calls are handled. These do not go to the general switchboard but are routed directly to a specially equipped order receiving table

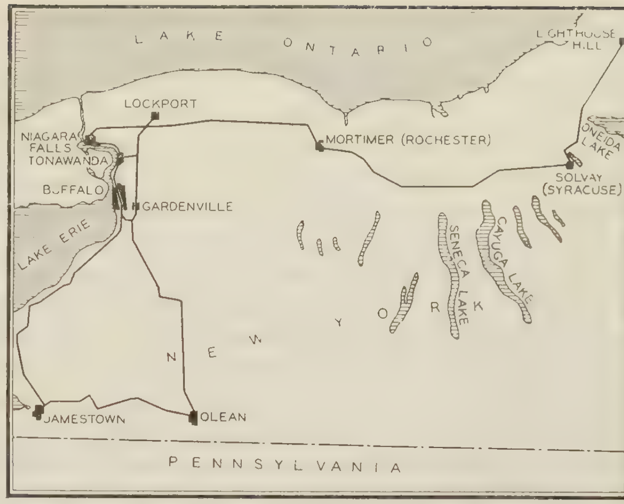

Fig. 2. Transmission system of the Buffalo, Niagara & Eastern Power Corporation (western division) showing principal switching points

where a specially trained personnel handle them directly without irritating department-to-department transfers.

Lines leased from the telephone company for full 24-hr. use connect the load supervisor (at Buffalo) with the Buffalo steam stations, the Niagara Falls hydro station, and the Lockport switching station, these being key points on the transmission system. Three of these leased lines provide remote-metering facilities for indicating at a glance the total load on the 60- and 25-cycle steam stations in Buffalo, and the hydro station in Niagara Falls, these being the three main power sources for the western division. Provision is made also for reaching Mortimer, Lyons, Solvay, and Syracuse through Lockport, and Gardenville, Jamestown, and Olean through the automatic dial-switching equipment in the Buffalo office. (See Fig. 2.)

In addition to the foregoing facilities the four main switching stations of the division, Niagara Falls, Lockport, Gardenville, and the Buffalo steam stations, are tied together directly by leased lines, so that district load supervisors may hold from two- to four-party conversations for discussing the proper execution of orders. The load supervisor's office is equipped with cordless turrets (similar to that shown in Fig. 5) for the interconnection of telephone lines of all types and for the quick and easy answering and switching of calls.

Among the many advantages of leased lines are these; that they do not follow the transmission right-of-way, and where two leased lines are in use between important points, they follow different routes. Both of these features enhance the inherent reliability of these lines. In addition, during storms the first responsibility of the power company is to maintain the transmission lines; where leased lines are used, the telephone company handles the communication problem. The possibility of storm failure is reduced to a

From "Communication in the Western Division of the Niagara Hudson System" (**No. 31-111**) presented at the A. I. E. E. summer convention, Asheville, N. C., June 22-26, 1931.

minimum, however, because practically all leased lines are run in cables.

Although the company is a large user of leased lines, thus eliminating maintenance worries and profiting from the advice of experts in the field of communication, privately owned lines belonging to predecessors are used where they were found to be in good condition. These private lines are interconnected with the leased lines, suitable protective equipment being installed at the connecting points. Such an arrangement provides great flexibility in the communication system and makes possible the use of previous investment in privately owned lines.

Eight carrier-current stations are maintained at main switching points, but under normal conditions these are not used to any great extent where leased lines are available; however, to make sure that it is in operating condition for possible emergency use each set is tested daily.

Interdepartmental Communication

In the company's branch exchange in Buffalo, and in several of the district offices, machine switching equipment has been installed. Calls from one department to another are dialed by the calling party directly, as are calls to the telephone company's central office. Operators on general office switchboards thus handle only incoming calls to that office. As a result, calls have been speeded up and in the Buffalo office the staff of operators has been reduced from nine to five, despite the fact that telephones served have increased in number from 189 to 325, with a corresponding increase in the amount of traffic handled.

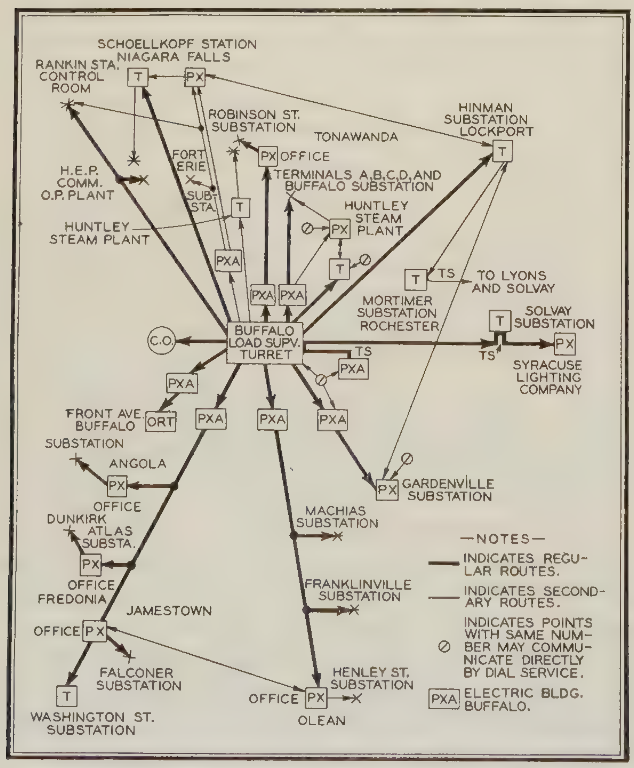

Fig. 3. Diagram of load dispatcher's communication facilities

In some of the smaller district offices, normal traffic will not justify the installation of machine switching equipment but service to customers, especially during times of trouble, will. In such cases operating men must be able to reach all parts of the system without interference from incoming calls. Where the dial system has been installed, the operating men can call the stations directly; a flood of customer calls thus does not interfere with their activities, and, at the same time, the telephone operator can devote undivided attention to customers.

Customers' Calls

Telephone calls from customers do not go to the general office switchboards but are routed directly to specially equipped order receiving tables. In the Buffalo office eighteen special trunks connect from the telephone company's central office to this table, and these are arranged in such a way that any call may be taken at any one of three different positions, there being a total of fourteen positions at the table.

Specially trained young women handle all types of these customer calls, which are largely reports of trouble, requests for service connections or disconnections, complaints, and requests for information. All positions at the table are connected by direct lines with the meter and trouble departments. Also ten tie lines connect the table with the company's machine switching equipment, thus allowing for connections to any one of the 325 extensions on this branch exchange.

Numbers are so listed in the telephone directory that customers rarely call the general office switchboard by mistake. When these errors do occur, however, they are connected by the telephone operator to the order receiving table without inconvenience and without being required to make a second explanation of what they want. Customers' calls which come to the service department but which really should go to the general office switchboard receive the same attention.

To maintain proper supervision over the telephone contacts with customers and at the same time bring about improvements in telephone usage, a monitor set has been installed so that observers may listen in on all conversations through the company's private branch exchange. Conversations are taken down verbatim and subsequently discussed at departmental meetings.

Five telephone typewriters connect this department with the meter and trouble departments located in the service building two miles distant. These teletypewriters are operated over leased lines and provide filled-in order forms on both the sending and receiving machines, the entire operation being completed within a very few minutes after the customer's request has been received.

Telephone contact with customers thus has been

centralized in a well-trained department with great improvement in public relations. The personnel of the department follows through each request to completion; and moreover the customer is not transferred, disappointed, or kept waiting.

Summary

The principal features of special interest in the communication scheme of this system briefly are that:

1. The company relies largely upon advice of the telephone company's engineers, believing that they are the best authorities available in the communication field.

2. Leased lined are used chiefly, thus freeing the company of maintenance problems and providing better and more dependable voice transmission.

3. Wherever practicable, automatic equipment is used for speedier service.

4. Both leased and private lines are interconnected for maximum flexibility.

5. In the interest of better public relations, great care has been taken to insure that customers' calls receive the best and most courteous service.

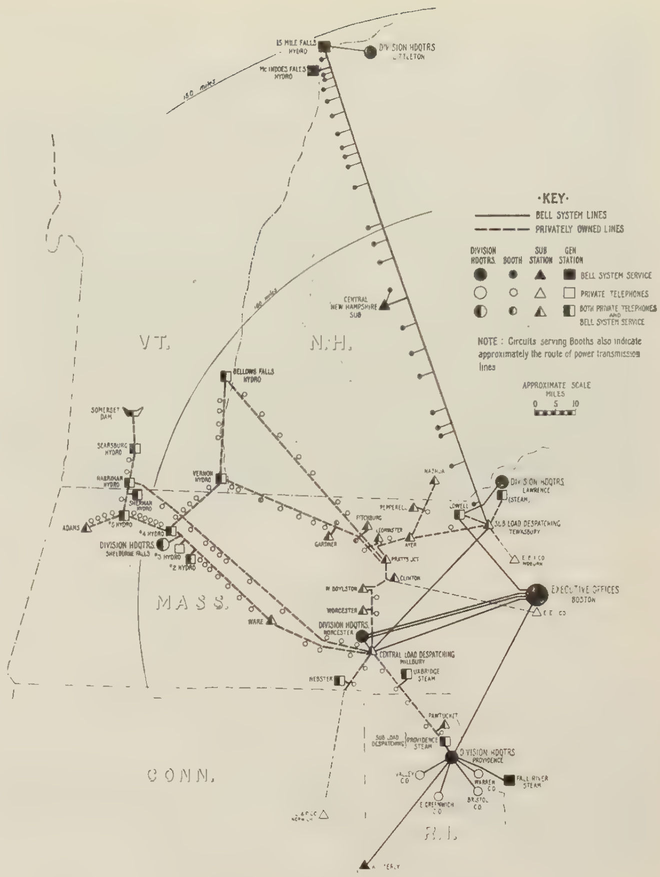

Fig. 4. Principal communication circuits of the New England Power Association

Joint Study Improves Communication Facilities

By
C. A. BOOKER New England Pwr. Assn., Boston, Mass.

M. E. CLARK New England Tel. & Tel. Co., Boston, Mass.

A LARGE GROUP of interconnected wholesale and retail electric companies are operated by the New England Power Association in a highly developed industrial area covering parts of five states. Energy is generated at eleven major hydro stations on the Connecticut and Deerfield rivers, whence it is transmitted over a high-voltage network to the load centers in central and eastern Massachusetts and Rhode Island; here interconnections are made with several large steam generating plants. To insure maximum economy in operation, a centralized control over all producing and distributing units is necessary.

To maintain this centralized plan of control, a network of communication circuits consisting of lines leased from the Bell telephone system interconnected with privately-owned lines has been set up (see Fig. 4). This arrangement represents the results of a joint study by executives of the telephone and power companies, instituted several years ago when the need for a more closely coordinated communication system was felt.

Operating control over the entire system is exercised by the load-dispatching department. This department has jurisdiction over power production, apparatus, safety work, the scheduling of future operations, and arrangements for power interchange with other systems. Control operations are planned from an extensive system of hourly reports received from each producing and distributing unit. Most of this work is carried on over approximately 600 mi. of privately owned telephone circuits.

For customer service and other commercial relations, regular subscriber service of the Bell system is used. Where the volume of traffic warrants it, P. B. X. (private branch exchange) switchboards are installed. Telephone extensions to the customers' service department are so arranged that all calls involving service on anything from flat irons to electric refrigerators are received at one place. This is done in order that such calls may receive prompt and sympathetic treatment without irritating transfers from one department to another.

Administrative activities of all units in the entire system are carried on from central offices located at Boston over a coordinated network of leased lines. By

From "Cooperative Study of Power System Communication" (No. 31-113) presented at the A. I. E. E. summer convention, Asheville, N. C., June 22-26, 1931.

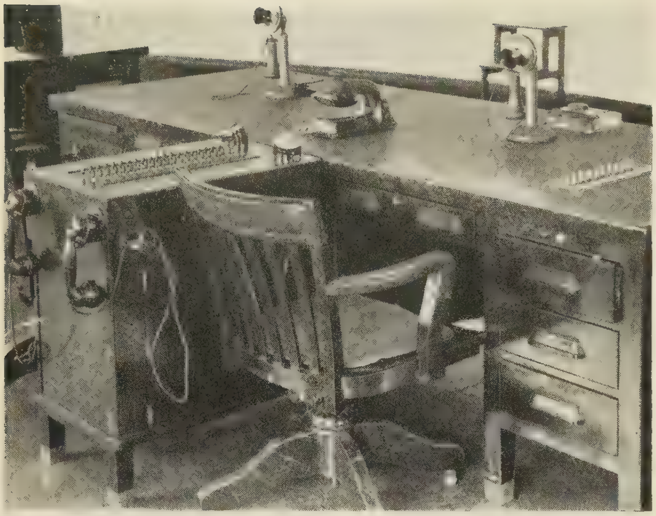

Fig. 5. Dispatcher's desk showing location of cordless turret wherein all communication lines terminate

interconnections at territorial office switchboards, economical and speedy communication with every part of the system is provided.

Joint Study Conducted

The joint study between telephone and power company engineers mentioned previously was instigated in 1929, when, with the consolidation of all of the principal offices at Boston, it became urgent to improve all types of service. In this study the entire communication problem was analyzed by parties having a thorough knowledge of modern telephone equipment, in cooperation with those most familiar with the operation and needs of the power system. Activities of the group conducting the joint study may be classified briefly as (1) a complete survey of existing communication facilities and usage; (2) the determination of present and future requirements; and (3) the analysis of these requirements to determine what alterations or additions are needed.

Results of Study

Although the survey has not been completed, many improvements in communication service already have resulted. Private branch exchanges serving local areas, districts, and divisions have been rearranged and in some cases modified to meet more fully the requirements of the territory served. In some instances these modifications have been effected at an actual saving in cost. Some of the more important findings of the joint study are outlined in some detail in the paragraphs which follow.

One of the earlier determinations of the joint study was the need for better call-handling facilities in the load dispatcher's office. It was desired to provide access to all lines but with a minimum of switching by the dispatcher. This was accomplished by the use of cordless turrets placed adjacent to the dispatcher's desk (see Fig. 5). The circuits were arranged so that the P. B. X. operator handles all calls not intended for the dispatcher, but at the same time the dispatchers have

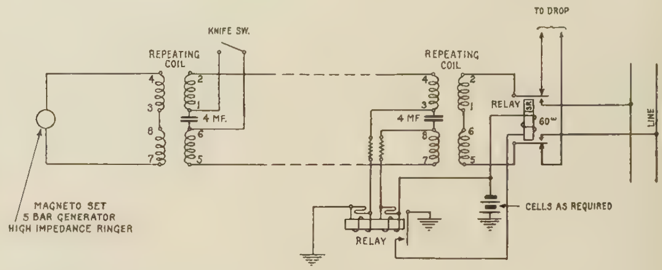

Fig. 6. Schematic diagram of patrolman's spur lines along the Tewksbury-Fifteen Mile Falls transmission line

full control of all lines for possible emergency use. Provision is made for visible as well as audible indication of incoming calls.

Another noteworthy result of the study is found in the reduction of noise on the company's privately owned lines. This was brought about by a complete field inspection and survey followed by the correction of transposition unbalances, clearing up of tree troubles, and the replacement of broken insulators and bad splices, wherever the survey indicated that these steps were necessary.

Advantages of the joint survey for determining future requirements were realized in the planning of communication facilities for the Fifteen Mile Falls hydro development in 1929. The final arrangements for this particular case consisted of leasing a line from the Bell system from Tewksbury to Fifteen Mile Falls (see Fig. 4) with a permanently bridged tap to the central New Hampshire substation. This decision was reached when it was considered that (1) in case of trouble the telephone company could furnish duplicate paths, (2) within a few years the entire line would be of so-called sleet-proof construction, and (3) that the annual cost to the power company would be lower than the cost of constructing and maintaining a privately owned line.

A novel feature of this particular line is the arrangement for communication facilities from patrol booths along the line (see Fig. 6). These facilities are provided by spur lines having an average length of about five miles, and extending from the booths to central offices through which the main line passes. These extensions normally are disconnected from the trunk circuit, but each line may be connected by simply closing a switch in the booth, the actual connection being made by a relay. Provision also is made to enable the patrol station to

signal the operator at the telephone company's central office in case exchange or toll service is desired.

Special arrangements have been made by the telephone company for routine and emergency maintenance of this line, and if for any reason the leased line is out of order preferential treatment is guaranteed for dispatching business over regular toll circuits.

Conclusions

Although the communication requirements of the New England Power Association have presented some unusual problems, joint consideration of these requirements has resulted in a satisfactory communication system. The provision of adequate communication service is essential to the operation of the power company, and in order that this may be accomplished economically and with minimum duplication of effort, as the requirements change in the future it is planned to continue the joint survey work.

Communication in a Metropolitan System

By
P. B. JUHNKE
Member A. I. E. E.
Commonwealth Edison Company, Chicago

COMMUNICATION facilities for the Commonwealth Edison Company system (Chicago) the fixed plant of which is scattered over the entire city, include 19 telephone switchboards, and a total of about 2,600 telephone stations. The main switchboard, together with seven sub-boards, are located in the Edison Building in the downtown section of the city. Of particular interest are the facilities employed in the technical direction and supervision over operating activities.

Operation of this system is carried on like most other large systems by a specially trained technical group located in a central load-dispatching office. Direct private-wire connections are provided between this office and all generating and distributing stations and the majority of substations. Dispatching activities are subdivided into three sections, two of them dealing with the usual routine of load dispatching, and each having supervision over a certain part of the system.

From "Communication Facilities of a Metropolitan Power System" (**No. 31-98**) presented at the A. I. E. E. summer convention, Asheville, N. C., June 22-26, 1931.

The third division known as the load-control section is of relatively recent origin and is charged with supervision over the supply of power from the different generating centers. This third section also has supervision over the 66- and 132-kv. tie-line elements between stations. These supervisory activities embrace not only generating stations and tie lines within city limits but also interconnections with, and supply from, generating stations outside of the city. Direct telephone communication is provided from the load-control group's own two-position board to all generating stations and 66-kv. switching centers.

Before the organization of the load-control section, its functions were carried on by the load dispatchers making this work part of their regular duties. When only two or three generating stations were in operation the load-division problem was fairly simple, but as other stations were added to the system, each in turn more efficient than its predecessor, this problem became more complex. Accordingly a system was set up whereby the load distribution was adjusted hourly on the basis of corresponding hourly load readings from the individual stations. Although this scheme worked out very well, it required almost continuous readings to distribute the load properly, and as more generating stations were added to the system it became quite a laborious process.

Load-Totalizing Scheme

As an outcome of the hourly system of load apportionment, a load-totalizer was developed to collect the individual station loads in the dispatcher's office, the power reading being transmitted by remote metering over telephone wires. Although this original arrangement represented a definite step forward, continuous direction on the part of the dispatching personnel was required to maintain the proper load apportionment. Accordingly, this original scheme was followed by further development known as the load-totalizing scheme with reverse indication. In this latter plan the totalization indications effected in the load dispatcher's office are transmitted back to the individual stations. With the aid of these continuous total-system-load readings and previously prepared load charts, each operator can hold the load on his particular station to its proper value at all times.

Remote-Metering System

The remote-metering system used in totalizing the station loads has been described in a previous publication. ("Budget-Plant Load Dispatching," by P. B. Juhnke and L. N. Moore, *Electrical World*, Vol. 89, pp. 1317-1320.) However, a number of improvements recently have been made in this apparatus. Instead of balancing the effect of the impulses by mechanical means as done originally, some of the recorders have been changed to operate on a resistance bridge arrange-

ment. With this improvement it is not necessary to install all of the meter elements on the load dispatcher's board. Several load recorders thus can be mounted in a relatively small space so as to be easily read by the personnel at the load-control board. Since all of the charts are controlled by the same synchronous motor, records may be compared directly and all meters will record for the correct time.

Metallic telephone circuits are used exclusively in this remote-metering scheme as installed by the Commonwealth Edison Company. However, the impulses (into which the load readings are translated) can be transmitted by means of carrier current,—a feature which materially enhances the usefulness of the system, especially for metering distant stations.

This type of installation is believed by the author to make possible the most intelligent operation of a large interconnected system. The task of directing load-scheduling activities is continuous and practically automatic. In addition, the economies gained in plant operation of a system of moderate geographic extent more than warrant the cost of the equipment and incidental telephone line rental.

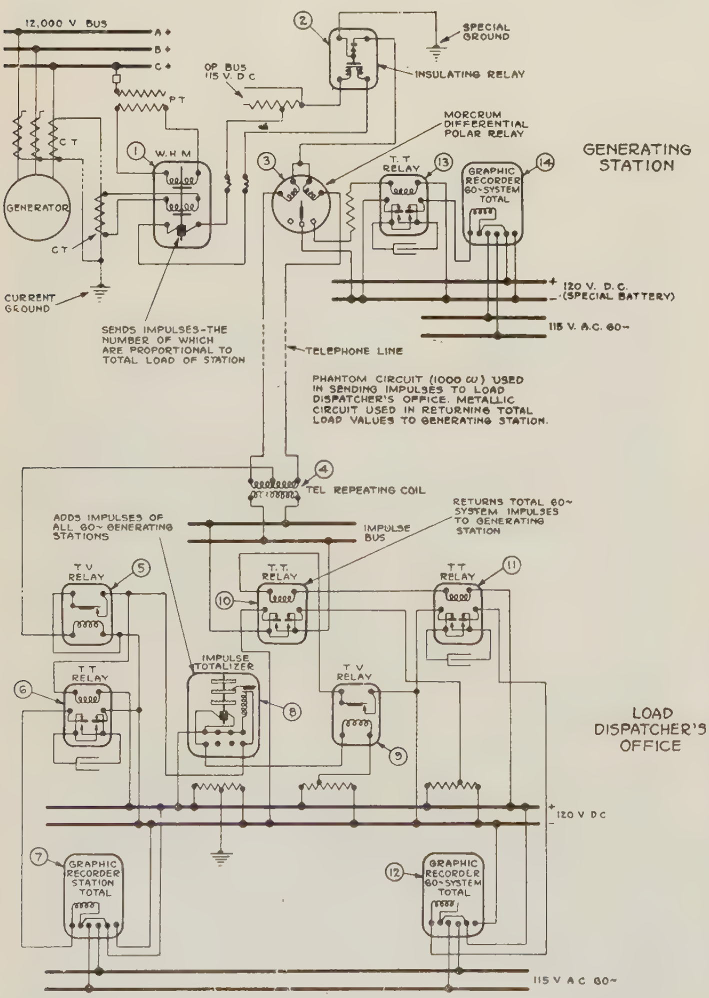

Fig. 7. Remote metering system used for load totalizing by the Commonwealth Edison Company

Carrier Communication Economical for Long Distances

By
E. C. STEWART — Arkansas Pwr. & Lt. Co., Pine Bluff

CARRIER-CURRENT telephony supplies most of the communication needs for the Arkansas-Louisiana-Mississippi interconnected system comprising a total of approximately 1,800 mi. of 110-kv. lines. Operating supervision for the entire interconnected network is centered in the load-dispatcher's office at the Woodward switching station near Pine Bluff (Ark.) except for the southern portion which is handled from the Jackson (Miss.) office. (See Fig. 8.)

Upon completion of Remmel Dam near Malvern (Ark.) in the latter part of 1924, and the connection of the hydro plant at that location with Pine Bluff and Little Rock, an urgent need for fast and reliable communication was felt. The construction of a new communication line along the power line right-of-way was contemplated but it was believed to represent an unwarranted expense when the reliability of such a line was compared with that of the power line itself. Finally, after a careful consideration of these and other factors involved, carrier-current equipment was installed during the early part of 1925. Results with this first installation were so satisfactory that in 1926 when the communication service had to be extended to Sterlington (La.) additional carrier-current equipment was used for this purpose.

Further extensions of this transmission system have necessitated corresponding extensions in the communication system; these likewise have consisted of carrier-current applications. At the present time a total of eleven carrier-current installations has been made located as shown in Fig. 8. In most cases comparatively long transmitting distances are involved, the longest of these being the 459-mi. stretch from Pine Bluff to Gretna.

To prevent the carrier waves from being dissipated on portions of the transmission system not used for communication purposes, by-passing and frequency-blocking equipment is installed at some locations. Arrangement of this equipment as installed at the Woodward switching station is shown in Fig. 9. Two transmitting sets are in use at that station so that additional blocking had to be employed.

Carrier-current equipment of the Southwestern Gas & Electric Company, shown also in Fig. 8, operates on a

From "Communication on the Arkansas-Louisiana-Mississippi Interconnected System" (**No. 31-116**) presented at the A. I. E. E. summer convention, Asheville, N. C., June 22-26, 1931.

frequency channel different from that of the Arkansas-Louisiana-Mississippi interconnection, but so far no frequency blocking has been found necessary between the two systems. For communication between the two systems separate receivers are employed at Pine Bluff and Shreveport.

With the exception of the Remmel Dam set, where antennas are used, all coupling between the carrier-current apparatus and the transmission lines is by means of capacitors. No failures have occurred on any of these units during the past two years, which is the maximum length of time that any of them have been installed.

Operation

The carrier-current installations on the interconnected system, supplemented by the use of toll service and one or two leased lines, are primarily for use by the dispatcher. A certain amount of business traffic is handled, however, outside of rush periods, and is relayed by the dispatchers to the parties addressed.

Records of the number of messages transmitted show that at the Woodward station the average number of carrier-current equipment operations per month is about 4,800 for both installations. A three months' study of the time of usage indicates that the average message length is only 1¼ min.

Direct communication between outlying stations on the interconnected system has not been allowed because there is little advantage in this from a system operating standpoint. Calls of this nature are handled through the Pine Bluff dispatcher, his office having been made a "central" for that purpose. To complete such a call, it is necessary for the substation instigating the call to signal the Pine Bluff dispatcher from whence the call is dialed to the station desired. Completion of the call is evidenced by the automatic starting up of the transmitter at the station called.

Up to the present time carrier current has not been provided along the lines for the use of patrol or maintenance men. Routine patrolling reports are not turned in by telephone except under emergency conditions when the nearest available form of communication is utilized. During the past three or four years whenever weather conditions have permitted emergency patrolling has been made by means of airplane. Reports of

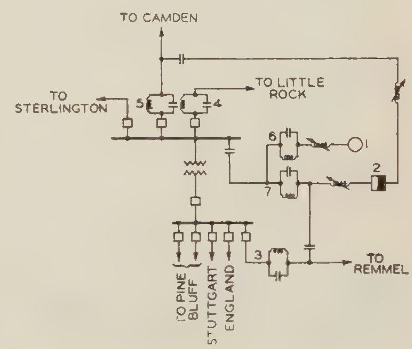

Fig. 9. Coupling, tuning, and blocking devices installed at the Woodward station

1 and 2. Carrier-current transmitters
3, 4 and 5. Resonant chokes
6 and 7. Traps to prevent interference between sets

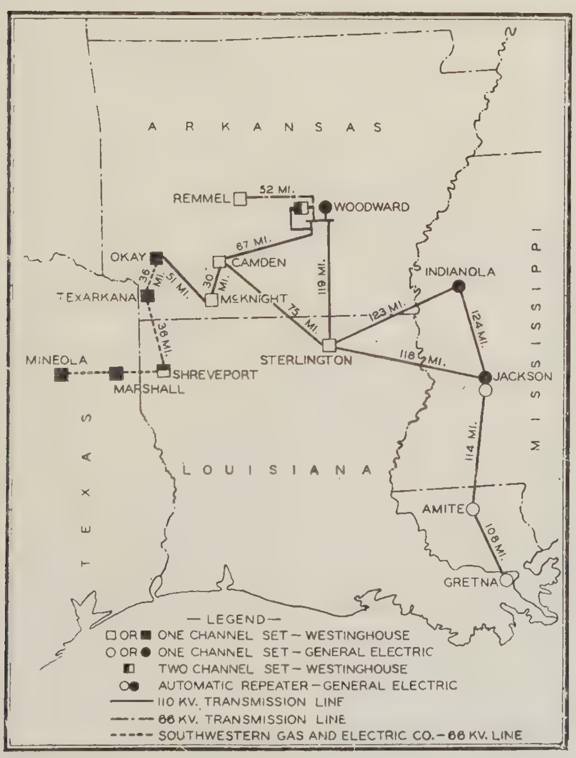

Fig. 8. Location of carrier-current sets on the Arkansas-Louisiana-Mississippi interconnected system

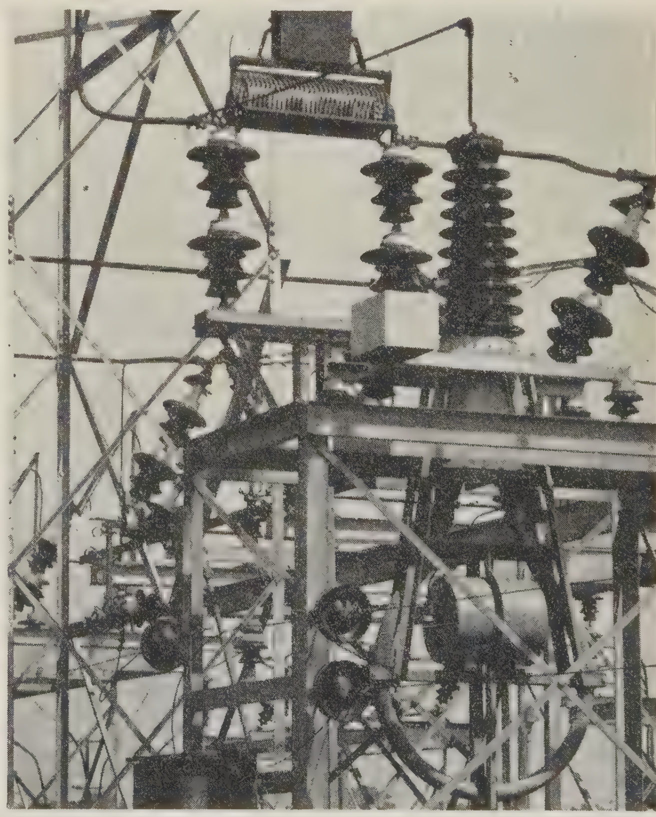

Fig. 10. Typical cable-type coupling capacitor and trap installation

observations made in this way usually are dropped in pasteboard containers to a substation operator, who relays the information to the dispatcher. In these reports, exact structure numbers are given in order to fix definitely the location of the trouble. Identification is made by means of distinguishing markers on top of key structures which are readily visible from the plane.

Reliability

A number of instances are on record showing that the carrier-current type of communication affords an extremely reliable type of service. Several times during storms when other means of communication were disabled, uninterrupted service was maintained over the carrier-current circuits. One instance of particular note occurred during the months of April and May, 1927, while the Mississippi Valley was engulfed in the great flood of that period. For many days carrier current provided the only means of communication to the Sterlington station.

The Way to Progress and Prosperity

Equitable taxes and fair distribution of the cost of government in place of the present unfair indirect bonus system is urged as a vital first step toward cultural progress and public welfare. This is the third article of The Engineering Foundation's symposium "Has Man Benefited by Engineering Progress?"

By
C. E. GRUNSKY President, American Engineering Council

UNEMPLOYMENT is the most striking symptom of recurrent hard times. Attribute this, if you wish, to the fact that one man now produces what three or more could produce a few years ago, but remember that demand in kind and quantity also has increased vastly. Depressions would be recurrent even if the typewriter, the harvester, and the automobile had not been invented. However, the relative number of basic producers has been materially decreased and, in consequence, increasing numbers must be provided with occupation in distribution, cultural activities, and recreation.

Opportunity to work should be provided for every person dependent upon his own efforts. Obviously this opportunity cannot be supplied at the bottom of the scale of human endeavor, else over-production would result. But, there is always room at the top. The great need is for a stabilizer, in the form of activities disconnected from the production of material necessities, which will provide in every country a steady flow of money from hand to hand. This stabilizer is close at hand. It will not prevent, but it will mitigate recurrent business depressions.

The nation's spiritual and cultural advancement are of greater importance than provision for material well-being. Expenditures of public funds for such purposes comparable with those for the safeguarding of life and property, for the protection of health, and for facilitating the exchange of products would not be unreasonable, but there is fear of the tax burden. Under a well balanced program the nation should get vastly more scientific research, expansion of educational opportunity, and encouragement of art. Education and art advancement should be provided for in all centers of population, by the erection of monuments, the establishment of museums, art galleries, and conservatories of music, and by the maintenance of opera houses with opera companies. These expenditures would contribute to the spiritual uplift of the people and to the progress of civilization. Provision for outdoor recreation should be made throughout the land on a scale never yet approached. Lands should be reserved and acquired so that those who go into the open may find suitable places to picnic and to camp. During periods of declining prices there also should be a speeding up of public works, on a sane program. Recourse to pick and shovel, instead of modern appliances, is but a trifle above giving a dole with its encouragement of idleness and of return to primitive conditions.

The basis of such a program of course is a high rate of taxation, and any suggestion that the government spend more money, particularly in business depressions, is commonly frowned down. The fact is ignored that when capitalists close their purses, government must spend to avert disaster. Objection should not be to the magnitude of the sum to be raised, but to the prevailing unfair systems of apportioning the tax. If the burden were distributed commensurately with ability to pay, there would be less dissatisfaction and the public soon would learn that the greater the tax the less the slump in the aggregate volume of the country's business.

Tax money thus put into circulation would create a volume of business that readily could bear the tax from year to year. To make this clear, let it be supposed that times are hard, money scarce, and that Jones has run up a bill of $100 at the grocers. The grocer has gone into debt to a truck gardener in the

same amount; the truck gardener owes the butcher \$100; the butcher owes the baker; the baker owes the plumber; and so on 100 times creating a total indebtedness of \$10,000 with 100 persons complaining of the difficulty of making collections. Jones finds employment and pays his grocery bill. The grocer pays the truck gardener with the \$100 received from Jones and so on until a single \$100 in a few days may have reduced outstanding indebtedness by \$10,000. The dollar started keeps on going from person to person normally from 30 to 50 times in a year, until hoarded somewhere or until its speed is checked during some business depression. If money received from equitably levied taxation is spent economically at home it will, in passing from hand to hand, create business in the long run for each taxpayer in substantially the proportion in which he has contributed. Each dollar thus expended by the government should create from 30 to 50 dollars of business in a year with, of course, some annual shrinkage. There appears no reason, in theory, why taxes should not be welcomed.

Much unproductive property, such as furniture and works of art, is too heavily taxed. So also is real estate. Why tax the goods or the material which the merchant or manufacturer has in stock when his business is "in the red"? They should pay something for the privilege of doing business, based upon the volume of business, and they should contribute to the government a part of the net profits. The tax on real estate should be just enough to prevent the land from lying idle too long. The main guide in fixing the individual's tax should be ability to pay, that is to say, his net income. Taxes should be graded and there might well be a minimum below which there would be no taxes.

Indirect bonuses have increased the tax burden of those who do not get such bonuses. The veteran is granted tax exemption, amounting in some states to \$1,000, an indirect bonus perhaps equivalent to \$40 or \$50 per year. Such exemption has almost universal approval. However, another veteran of necessity living in rented quarters with wife and children, and who therefore cannot benefit from the exemption, does not get the indirect bonus for which he probably is in much greater need. The exemption is unfair; every such bonus should be direct, not indirect.

Salaries of public employees and officials are tax free—equivalent to an addition to the individual's earnings—an indirect bonus automatically largest for those with largest incomes who best could afford to pay an income tax. Earned incomes are exempted from the federal base tax to an extent of 25 per cent. An indirect bonus equivalent to the tax on \$1,250 thus is given to the man who has a salary of \$5,000. His neighbor whose earned income is \$30,000 obtains an indirect bonus *six times as great*, yet the latter is in better position to pay. Scientific, religious, and like institutions are exempted, equivalent to giving a bonus. To the extent of the aggregate indirect bonuses thus granted, the other tax payers carry a heavier burden.

Government, state, and municipal bonds are tax free, supposedly for advantage to the public on the basis that they thus become marketable at lower rates of interest—only a fancied advantage that may lead to injustice. All the bonds issued by one municipality may be held by residents of another. In the second city a corresponding amount of property is taken off the tax list, with the result that all other property is more heavily taxed. The increased burden thus results in advantage to the residents of another municipality. If all bonds issued by a municipality are owned by residents of that municipality, the tax rate on the remaining property must go up in an amount that will more than offset the advantage which results from the low interest rate at which the bonds were issued. If the holder of the bonds did not profit by the tax exemption, the low interest rate bonds would not be attractive—another indirect bonus.

When the Panama Canal was constructed bonds for nearly \$400,000,000 were issued. These bonds went into the hands of bankers who deposited them in the United States Treasury for the privilege of issuing bank notes secured by these bonds. The bank notes, which may have approximated 90 per cent of the amount of outstanding bonds, went into circulation as currency, the banks thus being permitted to borrow from the public, at a small engraving cost and a moderate tax, hundreds of millions of dollars without paying interest—an indirect bonus.

Under the Reclamation Act of 1902, and its amendments, the settler is required to pay back to the government within 40 years the cost of the irrigation works, but without interest—an indirect bonus practically equivalent to the cost of the works. If constructed privately the works would have cost the settler twice as much.

Several cities in Kansas have no taxes, a situation welcomed by all. The cost of government has been shifted from the tax payer to the rate payer in water, light and power bills, and car-fares. The public utilities are owned by the municipalities and the profits are sufficient to meet the budget requirements. By this arrangement the *wealthy* have been *relieved of their just share* in the cost of government at the expense of those in moderate circumstances. Real estate owners and capitalists are presented with an indirect bonus.

Other illustrations could be given to indicate how general these indirect bonuses have become.

Equitable taxes and fair distribution of the cost of government is the first step to the expansion of activities for cultural progress and public welfare as a means of preventing extreme distress during business depressions.

Editor's Note: Pursuant to the invitation of The Engineering Foundation, the editors will be happy to receive comments, suggestions, criticisms, or discussions pertaining to this or the other articles published in this series.

The Simplex Synchronous Motor

Salient-pole synchronous motors with phase-connected damper windings are capable of developing high starting and pull-in torques with low starting current, as revealed by information given here.

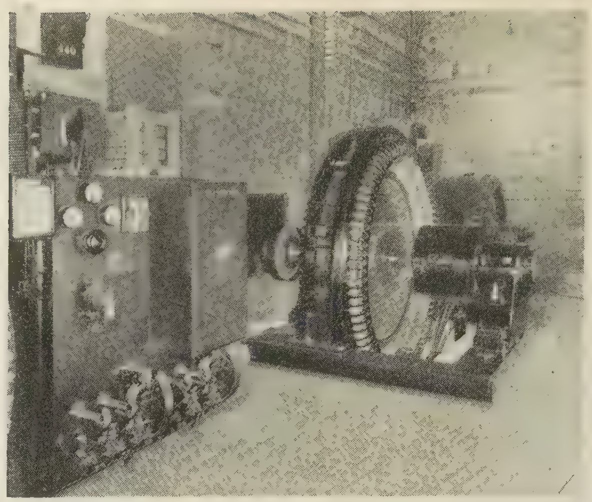

Fig. 1. A 300-hp. 164-r. p. m. synchronous motor of the phase-connected damper type and with associated control serving a cement plant

By
M. A. HYDE, JR.
Associate A. I. E. E.

Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

NOTEWORTHY PROGRESS has been made during recent years in the application of low-speed synchronous motors to industrial loads requiring both high starting and pull-in torques with moderate starting-current demand. The problems encountered are exemplified in the drive of grinding machinery in the cement and mining industries. There has been built for this type of service a form of salient-pole synchronous motor which develops these characteristics electrically without the use of any mechanical clutch or other loading device, and in a manner resembling the starting characteristic of the slip-ring induction motor.

Tests on machines of this type have shown starting torques in the order of 200 per cent of full-load torque, pull-in torques of 120 per cent and more, and starting-torque-per kva. ratios of from 0.6 to 0.7.

The construction is basically that of a two-bearing, coupled, salient-pole machine with certain deviations from the hitherto usual form. Instead of the ordinary cage form of damper winding this motor employs a damper winding consisting, as usual, of a single bar per slot in the pole face; but these bars are of low resistance copper and are connected to form a polyphase winding similar to the secondary winding of a slip-ring induction motor. This construction is shown in Fig. 2. The damper winding is connected through three slip-rings to an external grid-type starting resistor. In starting, this resistor is cut out in steps by the control as is done in starting a slip-ring induction motor and the damper winding circuit thus is given a succession of decreasing resistance values, providing advantageous speed-torque characteristics throughout the accelerating period.

From "The Synchronous Motor with Phase-Connected Damper Winding for High-Torque Loads," (**No. 31-43**) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

It may be noticed in the rotor illustrated that the pole faces are comparatively broad, permitting the damper winding to occupy a large portion of the pole pitch and to be favorably distributed from the standpoint of phase balance. To avoid the high eddy currents normally present during starting in the usual solid rotor rim, the rim of this machine is laminated.

The motor is started with field open-circuited; this eliminates the low-power-factor current that ordinarily circulates in the field when closed on a resistor at start, as commonly is done. The disadvantage generally resulting from open-field starting is the high transformer voltage on the field winding at start, and to obviate this several motors of the type described have been constructed with field designed for low-voltage excitation. These proportions involve higher excitation and fewer field turns, the latter resulting in lower transformer voltage on the field winding. A 1,000-hp., 1,800-r. p. m. 100 per cent power-factor motor constructed for low-voltage excitation required 8 kw. at 45 volts direct current, and developed at standstill by transformer action 3,300 volts across the field terminals. This voltage diminishes to zero as the rotor accelerates to synchronism.

Since the transformer voltage on the field at start is proportional to the number of field turns in series, the practise of field sectionalizing may be used. After extensive shop and service tests some motors have been built in which a centrifugally-operated sectionalizing switch is employed to break up the field into sections at start and to connect the sections in series after acceleration to a predetermined speed, when the transformer voltage is correspondingly reduced. A 300-hp., 164-r. p. m., 100 per cent power-factor motor employing such a switch and with a field designed for 125-volt excitation developed about 3,000 volts per section. The switch is built as a unit enclosed in a tight housing

and mounted within the rotor. Close scrutiny will discern one of these switches in the rotor of Fig. 2.

Control equipment employed with these motors is of magnetic definite-time-sequence type; its operation is explained by Fig. 3. In the control diagram the field is shown separated into three sections at standstill by the sectionalizing switch *F S*. In starting, the spring-closed auxiliary field switch *F*-1 is opened first; then the stator is connected to the a-c. supply with full starting resistance in the damper circuit. This resistance is shunted in steps by the closing of *S*-1, *S*-2, and *S*-3, and the motor accelerates along the corresponding speed-torque curves R_1, R_2, R_3, and R_0. Next the auxiliary-field switch *F*-1 is closed and the field, now connected to the field resistor, increases the induction-motor torque along curve R_{OF}. Finally d-c. excitation is applied by contactor *F*-2 and the motor synchronizes, operating thereafter as an ordinary salient-pole machine. In stopping, the centrifugal sectionalizing switch remains closed until a low speed is reached, permitting the field switch *F*-2 to be opened previously and a discharge circuit through the field resistor established. The control is arranged to prevent starting the motor with the field sectionalizing switch in the closed position. The auxiliary field switch is used to separate the field terminals from the control apparatus during starting, employing for this service a spring-closed contactor which ordinarily is mounted on a covered panel at the rear of the main panel.

The tabulation of starting performance given in Table I shows test results attained with several representative ratings during the development of this equipment. The starting-torque kva. ratios of 0.6 and 0.7 are about twice the values considered good for low-speed synchronous motors of ordinary construction when designed for similar torques.

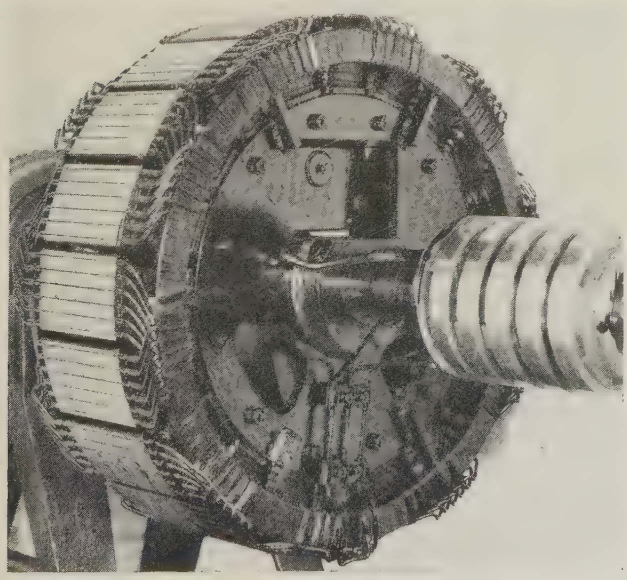

Fig. 2. Close-up of the rotor of a 225-hp. 360-r. p. m. motor with phase-connected damper windings

Table I—Simplex Motor Starting Performance

Hp. rating	1,000	300	300	350
Speed in r. p. m.	180	164	164	400
Power factor, per cent	100	100	100	80
Rotor rim construction	Solid	Solid	Laminated	Laminated
†Pull-in torque at 5 per cent slip	125	115	122	118
†Starting torque	210	210	230	190
†Starting kva., locked rotor	430	460	396	*268
Ratio of starting torque kva.	0.49	0.46	0.58	0.71

†Torque and kva. given in per cent of full-load value.
*Starting kva. based on 100 per cent power factor.

It is interesting to compare this motor with the ordinary compressor motor. With a current inrush of 275 per cent the standard compressor motor torques are 50 per cent starting and 40 per cent pull-in, whereas the simplex motor delivers with this same starting current a starting torque of 150 per cent and a pull-in torque of 120 per cent. This high starting performance is obtained without sacrifice of efficiency, with excitation characteristics suited to commercial d-c. voltages, and with starting torque adjustable in value to suit the needs of the installation.

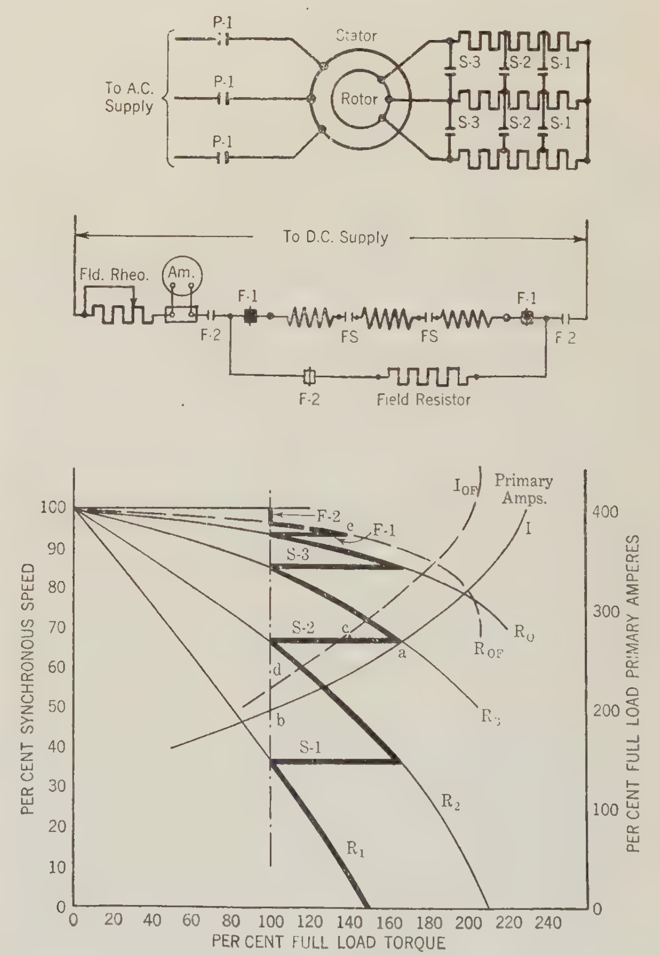

Fig. 3. Typical elementary control diagram (above) and associated speed-torque and current-torque curves (below)

Stabilization of Industry

Details are discussed of a plan which would provide for the regulation of industry through mutual trade associations under federal supervision. Production, consumption, and other factors would be coordinated to reduce cyclic variations; employees would participate jointly in providing unemployment insurance protection and other benefits which would accumulate for the employee regardless of legitimate changes in company or industry affiliations.

By
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IN THE SITUATION that confronts us at the present, the most disturbing aspect is that men who are able to work, who are competent workers, who, above all things desire to work, cannot find work to do. That this condition ever has been present in such periods detracts nothing from its wrongness. That industry must evolve and make effective those measures which first will ameliorate, and ultimately eliminate it, must be the reaction of everyone who gives thought to what is taking place. I say that industry must do this thing, because surely it will be done.

Benefits earned by a worker in one employment are wholly or in large measure lost by forced changes; or the right of choice of employment, which should be inalienable, is hampered. From the operation of individual life insurance and pension systems, however well conceived, has arisen the complaint of the "forty-year dead line," which it is claimed has seriously affected the ability of men exceeding that age to find new employment. Wide application is essential if benefits gained in one location are to follow the worker as necessity may indicate change of location, and this is a vital factor of any plan which will meet the need. If there were provided in the United States a system of benefits accruing through the life of the worker and following him wherever he might go, from shop to shop within a particular industry, or from branch to branch within industry as a whole, such provision would enlist, not merely interest on the part of the worker, but enthusiastic support.

An address delivered before the National Electrical Manufacturers Association at the Hotel Commodore, New York, N. Y., Sept. 16, 1931.

Production and Consumption Must be Coordinated

Industry exists basically for serving the needs of the people, and therefore production and consumption must be coordinated. Consumption is by the mass of the population, not the few, and the great mass of the population is made up of wage earners and their dependents. That they may be able to buy and satisfy their needs, they must have not only adequate incomes but must be sufficiently assured of the future to feel that they are safe in spending their money. The psychology of fear must be removed; and this cannot be done unless they have reasonable expectation of protection for their families in case of the breadwinner's death, protection for their old age, and protection against unemployment. By "protection" I do not mean a protection that is given to them, but I mean protection that they themselves help to provide.

Shall we wait for society to act through its legislatures, or shall industry recognize its obligation to its employees and to the public and undertake the task? Coordination of production is impossible under our present laws, and it is vain to think of their amendment or repeal unless the public is assured of the constructive nature of the steps industry will take, and that the interests of the public will be adequately safeguarded.

Underlying Principles

The general principles underlying what I am going to say are as follows:

1. Every effort should be made to stabilize industry and thereby stabilize employment to give to the worker regularity and continuity of employment; and when this is impracticable, unemployment insurance should be provided.

2. Organized industry should take the lead, recognizing its responsibility to its employees, to the public, and to its stockholders—rather than that democratic society should act through its government. If the various states act, industry will be confronted with different solutions, lacking uniformity and imposing varying burdens, making competition on a national scale difficult. If either the individual states or the federal government act, the power of taxation has no economic restraints.

3. There should be standardized forms of reports so that stockholders may be properly informed. As a result of the steady increase in number and size of corporations and number of shareholders, there has been much discussion of the uniformity, frequency, and regularity of reports of corporate activities, and considerable criticism of the form of these reports. Some are too conservative, some not sufficiently complete, while others are considered to be fair and complete. There is a lack of uniformity among the different companies.

4. Production and consumption should be coordinated on a broader and more intelligent basis thus tending to regularize employment and thereby removing fear from the minds of the workers as to continuity of employment, as to their surviving dependents in case of death, and as to old age. This should be done preferably by the joint participation and joint administra-

tion of management and employees. These things cannot be done by an individual unit—organized industry must do them.

5. If organized industry is to undertake this work, every effort should be made to preserve the benefits of individual originality, initiative, and enterprise, and to see that the public is assured that its interests will be protected. This can be done most effectively by working through the agency of the federal government.

There is nothing new or original in what I am proposing. I am merely bringing together well-considered propositions that have found support, including some that have been put into actual practise.

The following plan is offered as a means to correlate into a comprehensive whole the present undirected efforts of forward-looking business enterprises toward stabilization (1) for the further development of industry and commerce, (2) for the protection of employees and stockholders, (3) for the best service to the public, and (4) in general for the best interests of society. Legislation will be required to make such a plan possible, including the probable modification of some existing laws.

Trade Associations the Answer

An outline of the more important features of a possible "industrial constitution" is given in the following paragraphs:

1. All industrial and commercial companies (including subsidiaries) with 50 or more employees, and doing an interstate business, may form a trade association which shall be under the supervision of a federal body referred to later.

2. These trade associations may outline trade practises, business ethics, methods of standard accounting and cost practise, standard forms of balance sheet and earnings statement, etc., and may collect and distribute information on volume of business transacted, inventories of merchandise on hand, simplification and standardization of products, stabilization of prices, and all matters which may arise from time to time relating to the growth and development of industry and commerce in order to promote stabilization of employment and give the best service to the public. Much of this sort of exchange of information and data already is being carried on by trade associatons now in existence. A great deal more valuable work of this character is possible.

3. The public interest shall be protected by the supervision of companies and trade associations by the Federal Trade Commission or by a bureau of the Department of Commerce or by some federal supervisory body specially constituted.

4. All companies within the scope of this plan shall be required to adopt standard accounting and cost systems and standardized forms of balance sheet and earnings statement. These systems and forms may differ for the different industries, but will follow a uniform plan for each industry as adopted by the trade association and approved by the federal supervisory body.

5. All companies with participants or stockholders numbering 25 or more, and living in more than one state, shall send to its participants or stockholders and to the supervisory body at least once each quarter and in the prescribed form a statement of their business and earnings. At least once each year they shall send to the participants or stockholders and to the supervisory body a complete balance sheet and earnings statement in the prescribed form. In this way the owners will be kept informed of the conditions of the business in such detail that there may be no criticism of irregularity or infrequency of statements or methods of presentation.

6. The federal supervisory body shall cooperate with the Bureau of Internal Revenue and the trade associations in developing for each industry standardized forms of balance sheet and income statement, depending upon the character of the business, for the purpose of reconciling methods of reporting assets and income with the basis of values and income calculated for federal tax purposes.

7. All of the companies of the character described herein may immediately adopt the provisions of this plan but shall be required to do so within three years unless the time is extended by the federal supervisory body. Similar companies formed after the plan becomes effective may come in at once, but shall be required to come in before the expiration of three years from the date of their organization unless the time is extended by the federal supervisory body.

Protection for Employees

8. For the protection of employees, the following plans shall be adopted by all of these companies:

8A. *A Workmen's Compensation Act*, which is part of the legislation necessary under this plan, after careful study, shall be modeled after the best features of the laws which have been enacted by the several states.

8B. *Life and Disability Insurance.* All employees of companies included in this plan may, after two years of service with such companies, and shall, before the expiration of five years of service, be covered by life and disability insurance.

I. The form of policy shall be determined by the association of which the company is a member and approved by the federal supervisory body. The policy will belong to the employee and may be retained by him and kept in full force when he changes his employment or otherwise discontinues particular service as outlined later.

II. The face value of a policy shall be for an amount approximately equal to one year's pay, but not more than $5,000, with the exception that the employee may, if he desires, increase at his own cost the amount of insurance carried, subject to the approval of the board of administrators, later defined.

III. The cost of this life and disability insurance shall be paid one-half by the employee and one-half by the company for which he works, with the following exception: The company's cost shall be determined on the basis of premiums at actual age of employees less than 35 years old and on the basis of 35 years of age for all employees 35 or over and shall be a face value of approximately one-half a year's pay but limited to a maximum premium for $2,500 of insurance. An employee taking out insurance at age 35 or over will pay the excess premium over the amount based upon age 35. This will remove the necessity for restriction against engaging employees or transferring them from one company to another because of advanced age, as it will place no undue burden of high premiums upon the company.

IV. The life and disability insurance may be carried by a life insurance company selected by the trade association and approved by the federal supervisory body, or may be carried by a company organized by the trade association and approved by the federal supervisory body, or a single company may be formed to serve all associations.

V. The administration of the insurance plan for each company shall be under the direction of a board of administrators consisting of representatives, one-half appointed by the management and one-half elected by the employee members. The powers and duties of the board for each company will be to formulate general rules relating to eligibility of employees, etc., but such rules shall be in consonance with the general plan laid down by the general board of administration of the trade association of which the company is a member, and approved by the federal supervisory body.

VI. Provision for the continuation of a policy after an employee leaves one company and goes to another in the same association or goes to a company in another trade association, continuance of the policy after retirement on pension, provisions with regard to beneficiaries, total or partial disability, method of payment of premiums by payroll deductions or otherwise, weekly, monthly or annually, shall be embodied in the plan formulated by the trade association, with the approval of the federal supervisory body.

VII. If an employee leaves a company to go with one which is not a member of the trade association, if he engages in business for himself, or if he withdraws from industrial or commercial occupation, he may elect to retain the portion of the policy for which he has paid in whole or in part, by the continued payment of the proportional full premium costs; or he may receive a paid up policy, or be paid the cash surrender value for the part for which he has been paying premiums. The cash surrender value of that portion of the policy paid for by the company will be paid to the company which paid the premiums.

8C. *Pensions.* All employees of companies included in this plan shall be covered by old age pension plans which will be adopted by the trade associations and approved by the federal supervisory body. The principal provisions will be as follows:

I. All employees may, after two years of service with a company coming within the scope of this plan, and shall, before the expiration of five years of service, be covered by the old age pension plan.

II. All employees after two years' service may, and after five years' service shall be required to, put aside a minimum of 1 per cent of earnings, but not more than $50 per year, for the pension fund. The employee may if he desires put aside a larger amount subject to the approval of the board of administrators.

III. The company shall be required to put aside an amount equal to the minimum stated above; namely 1 per cent of earnings of employees but not more than $50 per year per employee.

IV. The above minimum percentage shall be the same for all employees who are less than 35 years of age when payments begin and the minimum percentage for these employees shall remain the same thereafter. The percentage to be set aside by employees coming into the pension plan at 35 years of age or over shall be so determined that it will provide a retiring allowance at age 70 the same as though they had begun 1 per cent payments at age 35. These provisions enable employees to go from one company to another in the same association or to different associations at any age, with provision for retiring allowance which will be not less than the minimum rate of an employee who entered the pension plan at age 35.

V. The amounts set aside by the employee and the company with interest compounded semiannually at five per cent until retirement at age 70, for a typical average employee, would provide an annuity of approximately one-half pay.

VI. The administration of the pension plan for each company shall be under the direction of a board of administrators, consisting of representatives, one-half appointed by the management and one-half elected by the employee members. The powers and duties of the board for each company will be to formulate general rules relating to eligibility of employees, conditions of retirement, etc., but such rules shall be in consonance with the general plan laid down by the general board of administration of the trade association of which the company is a member, and approved by the federal supervisory body.

VII. The amounts collected from the employees and the companies shall be placed with a pension trust organized by the association, the management of which shall be under the direction of the general board of administration referred to hereafter. In no case shall such funds be left under the control of an individual company.

VIII. The pension trust shall invest all funds and place them to the credit of the individual employees, including the income earned by the trust. If an employee goes from one company to another in the same association, the funds accumulated to his credit shall be continued to his credit with proper record of transfer. If an employee goes to a company in another association, the funds accumulated to his credit shall be transferred to his credit in the pension trust of the associaton to which he goes. If an employee goes to a company which does not come under these provisions or which is not a member of a trade association, goes into business for himself, or withdraws from an industrial or commercial occupation, the amount of his payments plus the interest at the average rate earned by the funds shall be given to him. If an employee dies before reaching retirement age, his beneficiary will receive the amount of his payments plus interest at the average rate earned by the funds. When an employee reaches retirement age the entire amount accumulated to his credit, including his own payments and those of the company plus accumulated interest will be given to him in the form of an annuity.

If an employee goes to a company which does not come under these provisions or which is not a member of a trade association, goes into business for himself, or withdraws from industrial or commercial occupation, he may elect to let the amount to his credit (namely, his own payments plus those of the company and the accumulated interest) remain with the pension trust for transfer, if he should return to the employ of any company coming within the provisions of this plan. If he does not return to the employ of a company coming under these provisions he may at any time thereafter withdraw the amount of his own payments plus interest at the average rate earned by the funds up to that time. Company contributions and accumulated interest, credited to employees who die or for reasons indicated above receive or withdraw their own contributions and interest, shall be returned to the employer or employers who made the contributions.

IX. The rules governing the payments of pensions on retirement and all other rules governing its continuance shall be made by the trade association, approved by the federal supervisory body, and observed by the general board of administration and the boards of administration of the member companies.

8D. *Unemployment Insurance.* All employees on piece work, hourly work, daily, weekly, or monthly work, with normal pay of $5,000 per year or less (approximately $96.15 per week) shall be covered by unemployment insurance.

I. All such employees may, after two years of service with a company coming within the provisions of this plan, and shall, after five years of service, be each required to put aside a minimum of one per cent of earnings, but not more than $50 per year for an unemployment insurance fund.

II. The company shall be required to put aside an amount equal to that put aside by the employees, as set forth above; namely 1 per cent of the earnings of each employee but not more than $50 per year for each such employee.

III. If a company regularizes and guarantees employment for at least 50 per cent of the normal wage paid each year to such employees, the company assessment for employees covered by such guarantee need not be made, but the employees will pay a minimum of 1 per cent of earnings, but not more than $50 per year, into a special fund for their own benefit.

If such an employee leaves the company, dies, or retires on pension, the amount to his credit in the special fund plus interest at the average rate earned by the special fund, shall be given to him or to his beneficiaries or added to his pension.

IV. If a company so plans its work that it is able to reduce unemployment, when the amount of such company's credit in the normal unemployment fund is equal to, but not less than, 5 per cent of the normal annual earnings of the employees covered, the company may cease making payment to the fund. Employees' payments will continue. The company will resume payments when its credit in the normal unemployment fund falls below 5 per cent of normal annual earnings of the employees covered.

V. When the weekly payments made from the fund for unemployment benefits amount to 2 per cent or more of the average weekly earnings of participating employees, the company shall retire an unemployment emergency, and normal payments by the employees and the company shall cease. Thereafter *all* employees of the company (including the highest officers) receiving 50 per cent or more of their average full-time earnings shall pay 1 per cent of their current earnings to the unemployment fund. A similar amount shall be paid into the fund by the company. The unemployment emergency shall continue until normal conditions are restored, which shall be determined by the board of administrators of each company. Thereupon normal payments will be resumed.

VI. The main provisions for the distribution of the funds shall follow along these lines unless modified by the board of administrators as set forth in section D paragraph VII hereof. A certain small percentage of the normal payments of the employees and the company may be considered as available for helping participating employees in need. A larger percentage of such normal payments may be considered as available for loans to participating employees in amounts not exceeding $200 each, with or without interest, as may be determined by the board. The balance of the funds shall be available for unemployment payments.

Unemployment payments shall begin after the first two weeks of unemployment and shall amount to approximately 50 per cent of the participating employee's average weekly or monthly earnings for full time, but in no case more than $20 per week. Such payments to individual employees shall continue for no longer than ten weeks in any twelve consecutive months unless extended by the board. When a participating employee is working part time because of lack of work and receiving less than 50 per cent of his average weekly or monthly earnings for full time, he shall be eligible for payments to be made from the fund, amounting to the difference between the amount he is receiving as wages from the company and the maximum to which he may be entitled as outlined above.

VII. The custody and investment of funds and administration of the unemployment insurance plan for each company shall be under the direction of a board of administrators, consisting of representatives, one-half appointed by the management and one-half elected by the employee members. The powers and duties of the board shall be to formulate general rules relating to eligibility of employees, the waiting period before benefits are paid, amounts of benefits and how long they shall continue in any year, whether loans shall be made in time of unemployment or need, whether a portion of the funds shall be placed at the disposal of the board for relief from need arising from causes other than unemployment, etc.; but such rules shall be in consonance with the general plan laid down by the general board of administration of the trade association of which the company is a member, and approved by the federal supervisory body.

VIII. If an employee leaves the company and goes to work for another company coming within the provisions of this plan, the proportionate

amount remaining of his normal contributions plus interest at the average rate earned by the funds shall be transferred to such company and to his credit. If he leaves for other reasons, dies, or retires on pension, the proportionate amount remaining of his normal payment plus interest at the average rate earned by the funds shall be given to him or to his beneficiary, or added to his pension. When such employee's credit is transferred to another company or paid to the employee or to his beneficiary under this provision, an equal amount shall be paid to the cooperating company.

9. *General Administration.* Each trade association will form a general board of administration which shall consist of nine members, three to be elected or appointed by the association, three to be elected by the employees of the member companies, and three representing the public to be appointed by the federal supervisory body. The members of the general board, except employee representatives, shall serve without compensation. The employee representatives shall be paid their regular rates of pay for time devoted to board work, and all members shall be paid traveling expenses, all of which shall be borne by the trade association. The powers and duties of this general board shall be to interpret the life and disability insurance, pension, and unemployment insurance plans, adopted by the trade association and approved by the federal supervisory body, supervise the individual company boards of administration, form and direct a pension trust for the custody, investment, and disbursements of the pension funds, and in general supervise and direct all activities connected with life and disability insurance, pension, and unemployment insurance plans.

Conclusions

The foregoing plan tends to put all domestic corporations of the class described on a parity for domestic business, thereby removing the inequalities of the different laws in the several states, provides for standard forms of financial reports and their periodical issuance for the information of stockholders, places on organized industry the obligation of coordinating production and consumption, and of a higher degree of stabilization. This will tend to assure more uniform and continuous employment for the worker and to remove fear from his mind, allowing him to devote himself whole-heartedly to his task. Cost of the product will include these items and will therefore be paid for by the users of the article or service and not in general by members of the community reached by the vicarious method of the imposition of a tax. Then organized industry will be in the position that it should rightly assume of serving the public, with public confidence and with the joint participation of workmen and management in the solution of these vital and far-reaching problems.

The following provision is suggested to place domestic corporations of the sort described on a parity with foreign competition: Any company engaged in export business may, upon application to, and approval by, the federal supervisory body, deduct from its federal income tax the equivalent of X per cent of its export sales, this X per cent deemed to be the equivalent in selling price of the various provisions for the benefit of employees which the company must make under this plan, and from which some foreign companies which the domestic companies have to meet in competition are free.

By this method American industry can discharge its obligation to its employees and by holding its position in world markets, bring additional work to America.

Synchronous Motors for Special Loads

The field of the synchronous motor can be considerably widened by variations in the design of normal motors of this type. Special requirements in starting current and in starting, pull-in, and pull-out torque can be met without resorting to unusual forms of motor design.

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SYNCHRONOUS motors have been applied in recent years to drives for which only the induction motor was formerly considered suitable. This practise has resulted from the need for motors operating at unity or leading power factor and for motors having high efficiency at low speeds. The use of synchronous motors for these applications has been made possible by great improvements in starting characteristics and mechanical design as well as new methods of control.

The conventional type of synchronous motor is of course the salient-pole machine, as it permits that the field-copper space be a maximum, thus taking full advantage of separate excitation with the large number of field ampere-turns required. Due to its greater excitation capacity, the salient-pole synchronous motor may employ a relatively large air-gap, which is mechanically desirable, without impairment of electrical characteristics. Small air-gaps on the order of 0.25 per cent of the pole pitch must be used on induction motors to reduce the magnetizing kva. Mechanical limitations prevent the use of air-gaps smaller than about 0.1 per cent of the diameter, so that induction motors with more than eight poles are definitely handicapped. The normal design of the salient-pole synchronous motor permits a natural air-gap of the order of 1½ to 2 per cent of the pole pitch and mechanical limitations are not reached until the motor has 60 poles or more. For this reason, the lower the speed the more favorable are the synchronous motor char-

From "Synchronous Motors—Design and Application to Meet Special Requirements," (**No. 31-52**) presented at the winter convention of the A. I. E. E., New York, January 26-30, 1931.

acteristics in comparison with those of the induction motor.

The large air-gap also makes possible the use of larger stator slots with consequent improvement of space factor and efficiency. As high-frequency flux pulsations cannot cross a large air-gap, thicker laminations may be used in the pole pieces. Space is provided in the normal design of the pole face for an amortisseur winding with ample heat capacity to enable the motor to start most industrial loads.

The normal type of synchronous motor which is best suited for steady-load operation has the above design characteristics. However, starting and accelerating characteristics vary with speed and horsepower, and the type of load may require motor characteristics different from those given by normal design. Without abandoning the basic form of synchronous motor outlined above, the electrical design may be proportioned to attain the characteristics required for many exacting operations.

A 100-hp. 60-pole motor will have high reactance, and consequently low starting and pull-in torque, while the 1,000-hp. 20-pole motor will have low reactance and high starting and pull-in torque. The empirical curves of Fig. 1 approximate the relationship between torques at synchronous and subsynchronous speeds for 60 cycles, 450 r. p. m., and lower. It is evident that for many applications involving low-speed motors it is necessary to find means of increasing the starting and accelerating torque; while for high-speed motors it is frequently desirable to reduce both the torque and the starting inrush. For the normal low-speed machine the starting inrush is 250 to 350 per cent of the kva. rating at approximately 30 per cent power-factor lagging; while for high-speed machines the inrush varies from 500 to 800 per cent of normal rating at 30 to 50 per cent power factor.

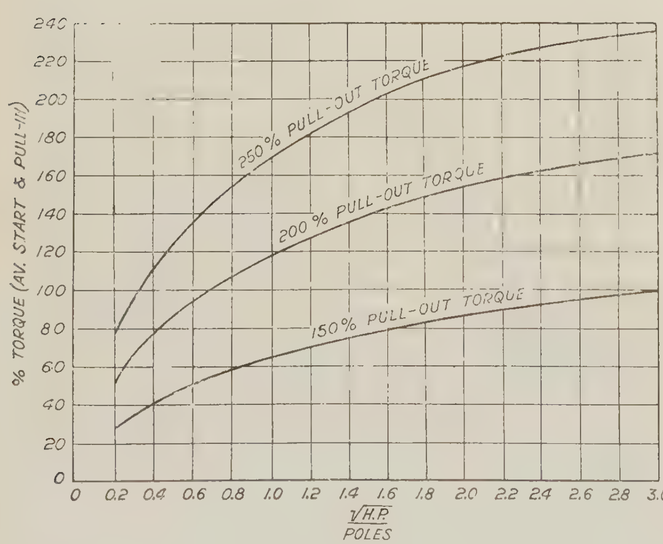


Fig. 1. Relation of starting torque to pull-out torque for various sizes and speeds of 60-cycle, unity-power-factor synchronous motors below 450 r. p. m.

Reduction of Starting Current and Torque

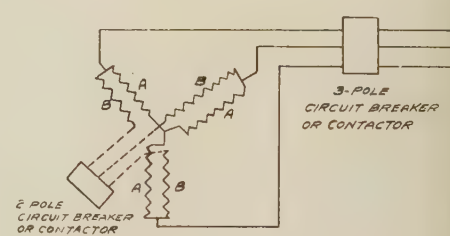
Heretofore where reduction of starting current or torque has been required, auto-transformers have been most widely used, while series reactors and resistors are sometimes used because of simplicity.

Increasing the reactance in the primary windings of the motor at starting reduces the inrush and torque without modifying the synchronous characteristics and without an external voltage-reducing device. This may be secured by the use of a double-circuit stator winding, the external connections being shown in Fig. 2. One branch of each phase is energized at start, the other branch being connected in parallel as substantially full speed is attained.

The reactance of the motor at start with only half the coils energized is much greater than with all the coils energized. The reduced current input creates less flux to act on the rotor and consequently less torque is developed, as shown in Fig. 3. As with reactor starting, the torque characteristics approach normal during acceleration. This is particularly desirable for blower and centrifugal-pump drives.

A somewhat different application of the double-winding motor is to start without shock high-torque loads such as ball mills, tube mills, and pulverizers. When the first circuit is energized, the motor develops sufficient torque to take up all gear and coupling slack. Energizing the second circuit starts and accelerates the load without shock to the mechanical parts, and voltage disturbances on the line are minimized.

Fig. 2. External connections for starting with double-circuit stator winding



Increase of Starting Torques

The need for starting and pull-in torques greater than those of a normal motor occurs most frequently with low-speed motors. Considering this group, the following methods are available for increasing the subsynchronous torques.

Oversize Motors. Increased torque in starting may be secured by an oversize motor, similar to the normal motor but built to larger dimensions for a given rating to make room for a greater total magnetic flux. Without restricting the magnetic section, the wide pole

pieces accommodate more bars. These may be arranged on a double squirrel-cage, using high- and low-reactance elements to improve the torque per ampere and to fit the speed-torque characteristics to the load requirement. The speed-torque curves in Fig. 4 indicate the uniform torque obtainable from start to synchronism.

This type of motor is widely used on rubber mills, ball and tube mills, crushers, and on certain types of compressors. High efficiency, ample thermal capacity

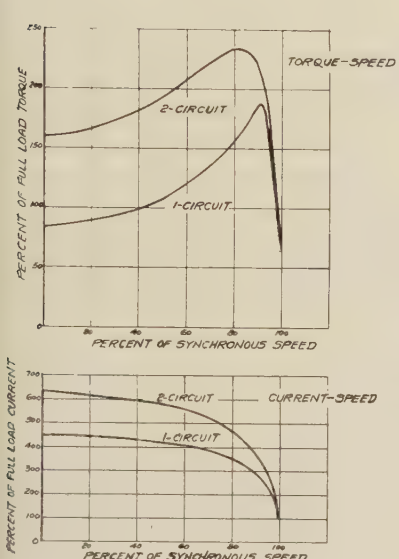


Fig. 3. Starting characteristics of an 800-hp., unity-power-factor, 1,200-r. p. m. synchronous motor with double-circuit stator winding

in the amortisseur winding, and simplicity in design, construction and control are the factors favoring this type of motor. Double-winding increment starting is available to meet objections to the sudden applications of high torque and to excessive voltage dips.

The use of the high-torque motor is extended by installing reliable intermittent rated capacitors for supplying part of the magnetizing current during starting. Frequently, one capacitor can be used for starting several motors, and by cutting out the capacitor in steps as the motor accelerates, the kva. demand may be regulated so as to prevent objectionable voltage variations.

Overvoltage Starting. Where high-torque design is at a disadvantage in very slow-speed rating because of excessive size, weight, or torque, a normal motor with overvoltage starting may well be applied. Overvoltage starting of normal low-speed motors does not present any difficulties to the manufacturer. With 150 to 175 per cent starting voltage, a low-speed, low-torque motor is not subjected to any higher percentage of current or torque than is a high-speed motor started on full voltage. The short, stiff end turns of the stator coils in a low-speed motor require little or no bracing to withstand starting stresses.

Overvoltage starting may be accomplished by stepping up the line voltage through an auto-transformer or by applying line voltage to only a part of a

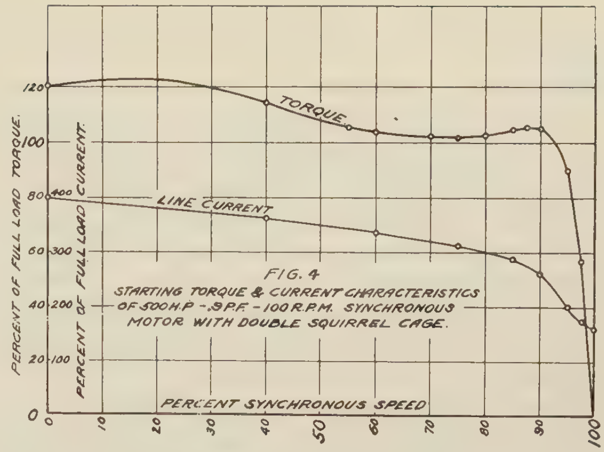


Fig. 4. Starting characteristics of a large low-speed rubber mill motor

transformer primary winding. Starting torque varies as the square of the applied voltage plus a slight increase which comes from the fact that saturation decreases the starting reactance. If high pull-in torque is also required, as for starting a pulverizer with full charge, the motor can be synchronized before the voltage is reduced to normal. This is best done without interrupting power so as not to let the motor drop out of step.

Delta-Star Starting. Delta-star starting has been successfully used on motors required to start a heavy load with moderate inertia characteristic, but since the circuit must be interrupted in changing to normal connections after synchronizing, it is doubtful if large high-voltage circuit breakers are sufficiently fast to keep the motor in step. Moreover, no adjustment of starting characteristics is possible except in the motor design.

Tapped-Winding Starting. Where it is found that a relatively small increase in starting or pull-in torque is required, a few coils of each phase may be cut out to decrease reactance and increase input. This procedure lowers synchronous reactance, raises densities and core loss, and calls for more excitation.

In a deliberate design it is possible to arrange the end connections so that a number of coils in each phase are cut out while starting on full voltage and picked up again after acceleration, so that full synchronous reactance is restored. Tests indicate an effect similar to, but weaker than, overvoltage starting.

Phase-Wound Starting Windings. As the wound-rotor induction motor with external rheostats in the secondary circuit has excellent starting torque and current characteristics, many attempts have been made to combine these with the advantages of synchronous operation. By using such a motor with slightly larger air-gaps and fewer and larger rotor slots than normal for an induction machine, the synchronous induction motor, widely used abroad, is obtained. The slip-rings are connected to rheostats in starting,

and to a d-c. source at speed. This permits a much higher ratio of starting torque to starting inrush than is obtainable in the normal motor.

The three fundamental difficulties with this type of motor are high cost, low efficiency, and high ratio of starting to rotor excitation voltage. The rotor starting voltage at full-load torque may be some fifty times the excitation voltage unless changes in connections are made. These difficulties tend to limit the application of the synchronous induction motor to a few cases of high-speed motors, where the disadvantage of increased excitation loss is minimized.

Another scheme that presents interesting possibilities is the use of a normal salient-pole synchronous motor with a phase winding in the pole phases. This scheme has the distinct advantage of permitting normal efficiency to be attained, but it introduces a more complicated mechanical construction, and does not permit as great a torque efficiency as the normal wound-rotor induction-motor construction. The phase winding must be carefully insulated and mechanically braced for high-speed motors, and this hampers accessibility of the field windings. To secure good starting characteristics and adequate heat capacity in the phase winding, it is desirable to use special pole construction at added expense. To permit full flux and torque to exist at starting, the field winding must be open-circuited, with resulting very high induced voltage unless special low-voltage excitation is used. To avoid the latter, it is customary to sectionalize the field winding while starting.

Supersynchronous Motors. The supersynchronous motor differs from the normal machine in that the external primary element is supported by bearings and is surrounded by a brake band. In starting, the primary is brought up to speed in the reverse direction and synchronized while the rotor with its connected load stands still. Gradual application of the brake slows down the primary, and starts and accelerates the rotor and load. Thus the pull-out torque of the motor is available during starting and accelerating, and rated power factor prevails. The advantages of smooth control of acceleration and controllable low starting current combined with high torque make this motor widely used in cement mills, on line shafts, mine fans, and similar applications. The design is not applicable to high-speed motors, and unless its unique characteristics are important for a specific application, it is generally preferable to use a normal-type motor with the proper control features.

One factor that should not be lost sight of is that in any group of commercial designs in standard frames, some ratings will have more favorable starting-torque characteristics than others; and in specific cases it is often possible to enlarge the amortisseur bars and increase the accelerating capacity well beyond the usual value. By this means normal-type motors may be built with an amortisseur winding to accelerate heavy loads, and much of the heat generated in the bars during a gradual acceleration passes directly into the pole pieces. The permissible temperature of the bars is not limited by contact with any insulating material. In low-speed motors the thermal capacity of the amortisseur seldom requires any modification of the normal design, because of the relatively large diameter required for a low-speed motor.

At the other extreme, two-pole synchronous motors are found to have excellent accelerating capacity in spite of the small motor diameter. By making the amortisseur in the form of very deep bars placed at the sides of rotor slots, a larger surface is provided for transferring heat to the rotor iron.

In general, for synchronizing with a large inertia, a normal motor with either a phase winding or a squirrel-cage can be designed with very low resistance to develop high torque at very low slip. It seems to be characteristic of most flywheel loads that the load at starting is not high; hence the moderate starting torque obtained with a low-resistance squirrel cage of normal reactance is usually adequate for starting loads of this type.

Synchronous Characteristics

The use of synchronous motors on steady loads does not present any unusual problems involving the synchronous characteristics. But where irregular loads and high momentary peaks occur, it is necessary to modify the normal design to insure successful operation.

In any application which involves wide swings of load, the first question in selecting a motor is the power supply. If the capacity is relatively large, and power swings corresponding in magnitude to the load swings are not objectionable, the first point is established in favor of the synchronous motor. If the supply is limited, and the load swings occur at very short intervals, the wound-rotor induction motor with a flywheel and a slip regulator is still in demand.

If it is found that the load swings can be assimilated by the power system, the characteristics of the synchronous motor itself must be considered. For any practical case involving peak loads of the order of one-half second duration or more, three alternatives are possible in applying a synchronous motor:

1. Provide a motor with sufficiently high sustained pull-out torque to carry the load without losing synchronism.

2. Remove excitation and allow the motor to run on the amortisseur winding, resynchronizing after load has been reduced.

3. Automatically apply excess excitation to motor field during heavy overloads.

The first method, which amounts to building an oversize motor, is particularly applicable where the load swings occur frequently. Although unity power-factor motors can be designed to develop 300 per cent pull-out torque or more by resorting to a very large air-gap and low-armature reaction, such motors in

general will be larger than leading power-factor motors which develop the same pull-out torque. Since the synchronous motor is often chosen primarily for power-factor improvement, motors of 80 per cent or even 70 per cent leading power factor are commonly selected.

Even with this torque available, motors are occasionally thrown out of step by extreme overloads, and a study must frequently be made of the flywheel effect of the machine, together with the sustaining torque of the amortisseur winding, to determine whether the motor can carry through the peak load without too great a reduction in speed. With adequate data the speed reduction can be estimated closely; and if this is not too large, the duty of accelerating back to synchronous speed will not endanger the amortisseur winding, since the heating of this element for a given output, varies with the slip.

After a motor has been forced out of synchronism, the d-c. excitation must be removed temporarily since otherwise the motor would generate a braking torque in opposition to the accelerating torque of the amortisseur winding. Then the load must be limited also to a value which will enable the motor to resynchronize, the means of limiting this load depending upon the type of load.

For meeting such conditions where the motor may be pulled out of step frequently, the synchronous induction motor would be well suited except for the inherently low pull-out torque of this type. If designed for good starting characteristics, unity-power-factor designs will have only 120 to 140 per cent pull-out torque. By designing for 0.8 leading power factor, 175 to 200 per cent pull-out torque can be obtained. If the overexcitation is further increased to obtain still higher synchronous torque, the loss in efficiency may be serious. Obviously, the wound-rotor machine can be justified only by very severe accelerating duty or starting current requirements.

Many possibilities for increasing pull-out torque are presented by quick-response excitation. If a synchronous motor is subjected to occasional peak loads much greater than the average load, and the field excitation can be quickly increased to meet these overloads, a material reduction in the size and cost of the motor is sometimes possible. In addition, the motor may be designed for best efficiency at the average load condition, and the motor power factor will be held more nearly constant during the load changes. The problem is the same as that involved in overexcitation of generators to maintain synchronism during short circuits, except that most industrial motor installations cannot justify the refinement and expense of the equipment used with large generators.

When a heavy load is suddenly applied, a synchronous motor can momentarily exert a torque far greater than its sustained maximum torque. This usually gives sufficient current for changes in excitation to be made, provided the excitation system is sufficiently fast. In the larger motor sizes, modification of the exciter may be necessary to increase its rate of voltage rise. For small motors, such as 100-hp., usually it will be more economical to build a motor having this higher torque inherently, than to resort to overexcitation with a larger exciter and additional control.

Another method of overexcitation which is sometimes used is to operate a 125-volt exciter at 175 or 200 volts for example, and dissipate the difference between this value and 125 volts in a fixed resistor in series with the motor field. A contactor is then used to short-circuit the resistor when the motor load exceeds a predetermined value.

Interesting possibilities are found in the use of electron tubes for overexciting a synchronous motor, although this has not yet been applied commercially. In applying any field-forcing scheme, the motor field must be of liberal design so that the intermittent high excitation will not overheat the field coils. With adequate margin provided, however, the field winding can still be considerably smaller than that of an equivalent high-torque motor which carries high excitation current continuously.

Severe Lightning Tests Made on "Surge-Proof" Transformers

AN INTERESTING SERIES of lightning tests was made on Sunday, August 23, by the Westinghouse Electric and Manufacturing Company on each of four 42,000-kva., 220-kv. single-phase transformers. These units are of the new non-oscillating surge-proof type of construction recently developed by this company, which states that the transformers embody features of insulation design effecting greatly improved impulse strength.

These tests are claimed to be significant for two reasons: first, that the transformers are by far the largest commercial transformers on which actual lightning tests have been made; and second, that the tests were much more severe than any heretofore applied to a commercial transformer. Each transformer was set up with a 64-in. protective gap, and connected to the surge generator with a short line supported by a string of fourteen standard insulator disks. The following tests then were carried out:

1. Several long-wave surges were applied to the transformer, the voltage being raised gradually until flashover of the protective gap took place.

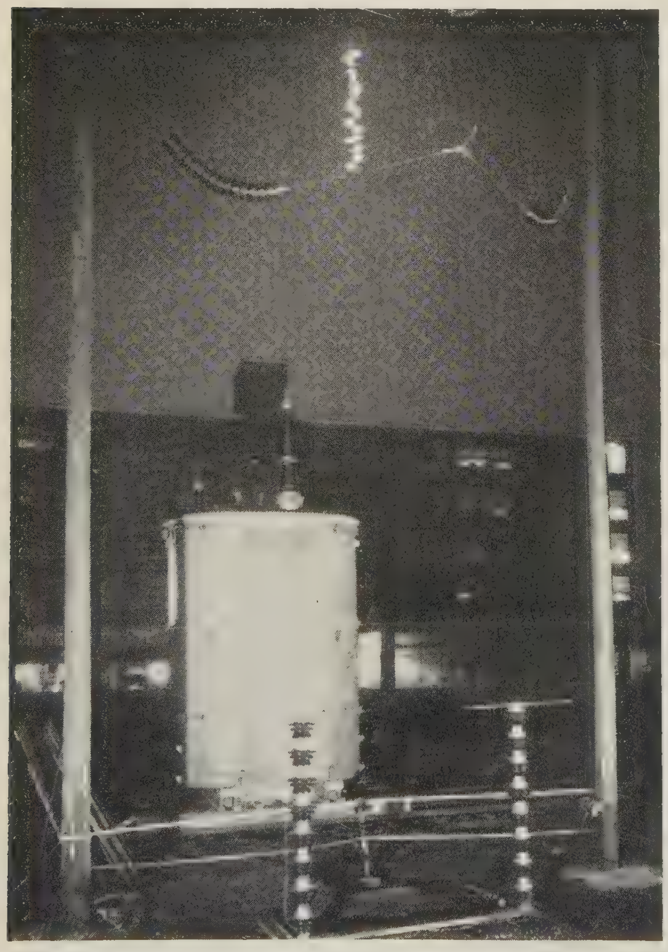
2. The gap was then removed and long-wave surges of still higher voltage applied until the string of fourteen standard insulator disks flashed over.

3. The insulator string was replaced by one having twenty-one disks and the voltage increased until flashover of the transformer bushing occurred.

4. In order to simulate a direct stroke of lightning, a surge which rose to the flashover value of the protective gap was applied in a small fraction of a microsecond.

The first three of these tests proved that the requirements of coordination between the four elements, transformer insulation, bushing, line insulation, and protective gap, had been met. They also showed that the longest waves that could reach the transformer, even with an over-insulated line and no protective gap, produced no internal oscillations to overstress the insulation between the winding and ground.

The steepest wave front produced by natural lightning which has been recorded to date was found by Pittman and Torok (see ELECTRICAL ENGINEERING for July 1931, p. 494) to have a rate of rise of 4,000 kv. per microsecond. The wave front used in the fourth test above was nearly three times as steep as that measured by Pittman and Torok. It was thus proved that the transformer would withstand surges representative of the severe conditions of a direct lightning stroke on the line close to the apparatus. At no time during these tests did the transformer show any signs of distress. After the lightning tests were completed, the regular A. I. E. E. insulation tests were repeated as further evidence that the transformer had suffered no damage.



Flashover of line insulator with fourteen standard disks at approximately 1,300,000 volts

Relaying with Two Pilot Wires

The fastest relay scheme for isolating a faulty section of transmission line is the pilot-wire system. This usually requires four wires between stations, and therefore cost limits its application to short sections of line. A modified scheme is described herewith which reduces the number of wires needed.

By
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PILOT-WIRE RELAYING for transmission lines has the advantage of giving fast operation and of being independent of the setting of selective relays. With the usual definite time relays, the time settings of the relays must be increased in each successive section of line. This means that the section near the generating station frequently has such long settings that low-voltage conditions during faults on the system may exist long enough to drop synchronous equipment out of step. In certain cases, other forms of relays may be applied to obviate this difficulty, but the pilot-wire scheme is ideal from the standpoint of quickly isolating the faulty section of the line. It is especially advantageous in eliminating the difficulty of relaying on complex loops and networks.

The usual scheme of pilot-wire relaying consists of balancing the secondary currents of current transformers at both ends of the line. This requires four pilot wires between stations, and their cost usually limits the application of this scheme to short lines. The telegraphic pilot-wire relay scheme developed by the Oklahoma Gas and Electric Company requires one, or preferably two, pilot wires, and is therefore applicable to relatively long lines. It insures quick isolation on the occurrence of any type of line or ground fault where there is a source of power at both ends of the transmission line section. In addition to the pilot-wire relays the usual selective relays are used as back-up protection against the failure of the pilot wire. A supervisory system can be installed and is desirable to enable the operator to check the conditions of the telegraphic circuit at any time. Also, this circuit may be used simultaneously for telephone communication.

From "Telegraphic Pilot-Wire Relay System" (**No. 31M13**) to be presented at the A. I. E. E. South West District meeting, Kansas City, Mo., Oct. 22-24, 1931.

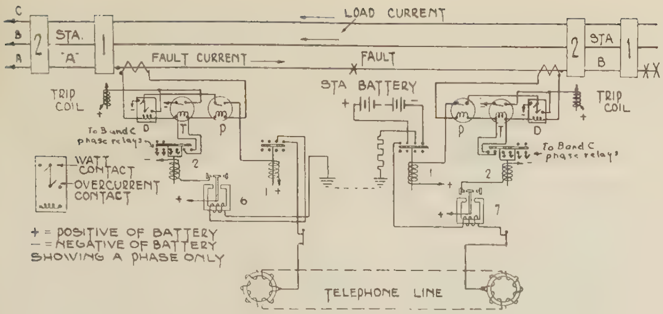

Fig. 1. Fundamental scheme of pilot-wire relay system

To remove hazards to life or equipment all current and potential transformers are grounded securely.

It usually will be more desirable for the operating company to lease the pilot wires from the telephone company than to own and maintain its own lines, as telephone wires strung on the high-voltage line towers are not feasible due to the high induced voltages; separate structures therefore are necessary.

The pilot-wire scheme consists essentially of directional and non-directional overcurrent relays at each end of the line, operating on low current flow into the section being protected. Current flow from either station into the line causes these relays to operate a transfer relay at the same station. The contacts of these transfer relays at both ends of the line are in series with each other through the pilot wire and ground return. The occurrence of a fault on the line section causes the current relays at both ends to operate, energizing both transfer relays, the contacts of which close the telegraph-wire circuit. Thus through auxiliary relays the tripping coils of the oil circuit breakers on both ends of the line are energized.

The details of the fundamental scheme are shown in Fig. 1, the current relays in phases *B* and *C* being identical to those shown for phase *A*. The watt contacts of the directional overcurrent *D* close when current is flowing away from the station bus. The overcurrent contacts of relays *D* are given relatively high current and time settings and form the secondary or "back-up" system. Relays *T* and *P* are overcurrent relays of the pilot-wire scheme and are given low settings. Upon the occurrence of a short circuit at *X*, the watt contacts on relays *D* and the overcurrent contacts on relays *P* at both stations *A* and *B* operate. This energizes transfer relay 1 at each station which closes the pilot-wire circuit through the operating coils of relays 6 and 7. These latter in turn energize relays 2 which remove the short circuits from the current coils of relays *T*. These are given instantaneous time settings, and current settings only slightly over the maximum load current so that when a fault occurs on the section and the short circuit is removed from the operating coils of relays *T*, both circuit breakers are tripped at the same time. Although only one pilot wire with ground return may be used, the use of two pilot wires and ground return as shown in Fig. 1 gives more reliable operation. These lines are usually leased in pairs, and by connecting them through a repeating coil at each end, satisfactory operation may be secured even with an open circuit on one line or a short circuit between lines, provided there are no grounds.

The purpose of the overcurrent phase selective relays *P* is to isolate the watt contacts of relays *D*. If the latter were connected in parallel, incorrect operation would result during certain cases. For example, if these watt contacts in each phase were not isolated and a short circuit occurred at *X X*, circuit breaker 1 at station *A* and circuit breaker 2 at station *B* would be opened. Considering the relays of circuit breaker 1 at station *A*, relay *P* and the watt contact of *D* in phase *A* would, of course, close due to fault current and energize the transfer relay at station *A*. Considering the relays for circuit breaker 2 at station *B*, load current would tend to close the watt contacts of relay *D* in phases *B* and *C*, and the contacts of relay *P* in phase *A* also would be closed by the fault current. It is apparent therefore that if these watt contacts were not isolated by relays *P* in each phase, the transfer relay would also be energized to complete the circuit through the pilot wire and trip the circuit breakers on the good section of line.

A lock-out scheme, the elements of which are shown in Fig. 2, further insures correct operation. The operating coil of multi-contact relay 8 is connected in parallel with that of transfer relay 1 of the switch on the opposite side of the same station. Relay 8 short-circuits the current coil of relay *P*. A fault at *X* which would cause circuit breaker 2 at station *A* to open would also energize lock-out relay 8 of circuit breaker 1 at station *A*, so that this latter circuit breaker could not open on through fault. This is desirable as the opening of circuit breaker 2 might set up transients which would close the watt contacts of the relays on circuit breaker 1. This condition would result if a synchronous condenser, a generator, or a transformer bank with the high-voltage side connected star and having its neutral grounded, were connected to the bus at station *A*.

A supervisory system, shown in Fig. 3, is used to give a continuous indication of the condition of the pilot

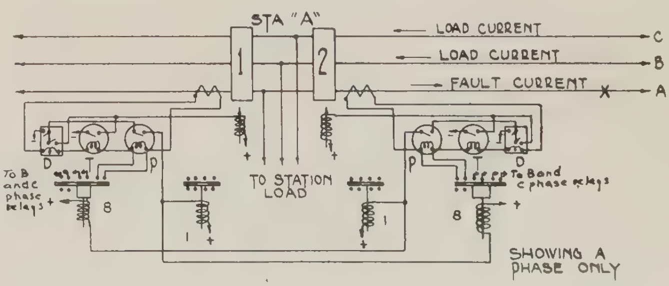

Fig. 2. Lock-out scheme of pilot-wire relay system

and wire to indicate operation of the equipment. Any operations of either the supervisory relay 4 or of the polarized relay 2 will give an indication on the recording voltmeter. The supervisory relay circuit is energized at all times unless the pilot-wire circuit fails or an operation of the transfer relay 1 occurs. Normally, the contacts of relay 4 are in the closed position and due to the resistor in the circuit the voltmeter reads slightly lower than battery voltage. If relay 4 is de-energized due to an open circuit or a ground in the pilot wire, the voltmeter will read zero and an alarm will sound. At station *B*, relay 3 will remain energized on a grounded pilot wire, but an increased reading on the milliammeter will result.

The telephone system by which the operators at two stations may communicate with each other is also indicated in Fig. 3. When it is desired to test the condition of the pilot-wire system the operators communicate with each other by telephone, and then operate the push-buttons in each station to cause both transfer relays to become energized. If there is no trouble on the pilot-wire system the alarm will sound.

Provision is made also for instantaneous clearing of a faulty section in the event of a substation operator closing a circuit breaker on a faulty line after the circuit breaker has tripped. This is accomplished by connecting the coil of relay 9 in parallel with the circuit breaker closing coil. Relay 9 is energized by pulling the closing button and then closes its contacts to remove the short circuit from the tripping relays *T*. If the current is abnormal, the switch will trip immediately without the assistance of the pilot-wire features.

One of the refinements which may be utilized is the use of a single pilot-wire installation protecting two parallel transmission lines. This scheme requires additional polarized relays which function only when current is flowing in one direction.

There are 193.5 mi. of actual telegraphic lines used by the Oklahoma Gas & Electric Company for the protection of its 66-kv. system. Over a period of five months, and during the most inclement weather, the total outages of the pilot wires amounted to 182.5 hr. or 36.5 hr. per month. During the first six months of 1931 there were 38 correct operations and only three incorrect operations. These were all caused by lightning closing the telegraph relays at one station while there was trouble on the adjacent section. Cycle counter tests have revealed that the entire equipment functioned in from 9 to 12 cycles, and with unvarying precision.

Although the telegraphic pilot-wire system is applicable to loops and networks only or where current is flowing into a fault from both directions, its use has been found to be justified by its quickness of operation on all types of line and ground faults. Since it is frequently necessary to lease wires from the telephone company for communication purposes, and the same wires can be used for the pilot-wire relay system, the additional expense in such cases is small. Another advantage is that where a power system is expanding rapidly, this pilot-wire relay scheme can be applied without rearranging the entire relay system.

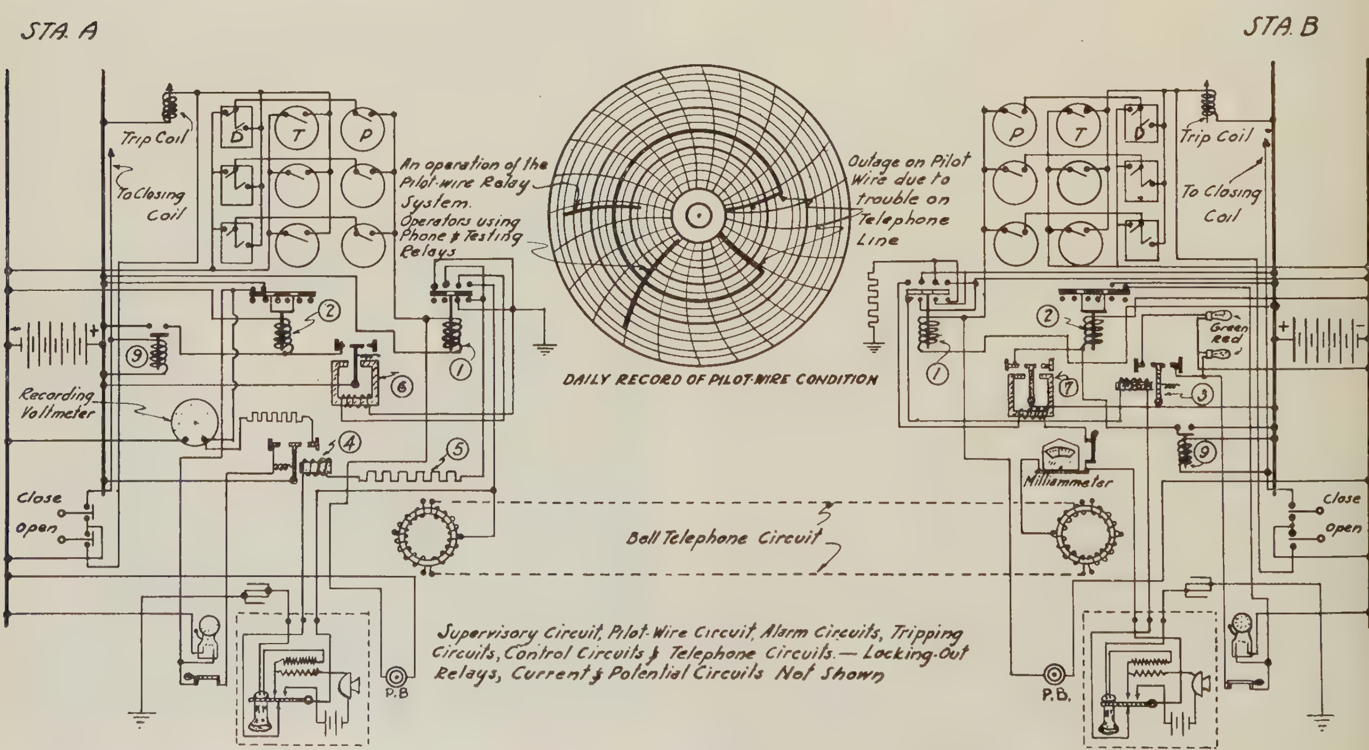

Fig. 3. Complete pilot-wire relay scheme except for lock-out relays and instrument transformer circuit

Experiments With Short Arcs

Observations were made on all phases of the arc discharge, including the transition period between the glow and arc stages. Current density at the cathode is shown to be the factor determining when that transition will take place, rather than the temperature of that element as was thought formerly.

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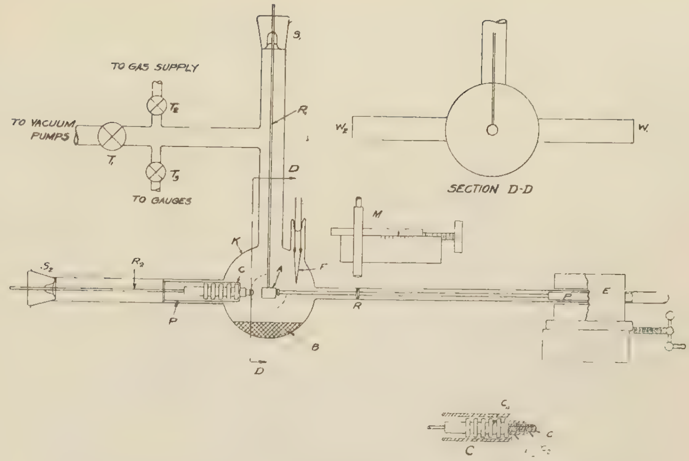

Fig. 1. Apparatus for studying the characteristics of low-current arcs in different gases

PHENOMENA associated with arc discharge between cold metallic electrodes are unusually complex, and in general not well understood. In view of the growing use of the arc commercially, especially in industrial welding operations, a further study of the physical mechanism underlying this particular type of discharge seems warranted. This investigation is concerned chiefly with short arcs (a few millimeters) between iron and copper electrodes in air and some of the inert gases, the gas pressures ranging from atmospheric to about 1 mm. of Hg. Particular attention has been devoted to the transition period between the so-called abnormal glow discharge and the actual striking of the arc.

Previous investigations have shown that this transition period is quite abrupt and many workers have doubted even the existence of such a transitory region. One common belief is that as the glow spreads over the electrode surface, the cathode gradually becomes heated sufficiently at some point to start an arc. In the present tests, however, a continuous transition was observed not only from the glow to the arc, but also in the reverse direction. The results indicate also that current density at the cathode rather than the temperature of that electrode is the factor determining when the transition takes place.

In the first series of tests a number of experiments were made on the arc discharge itself with currents ranging from 1 to 20 amperes. The arc current was supplied from a 250/500-volt d-c. generator, the current being adjusted by means of an external series resistance. In order to obtain reproducible results electrodes of approximately the same size and shape were used throughout, a convenient size having been found to be 1/8—3/16 in. in diameter and 2 in. long.

From "Some Experiments with Arcs Between Metal Electrodes," (No. 31-14) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

Characteristics of Arcs in Various Gases

In this group of tests, results in general were found to agree fairly well with those of previous investigators. Steady arcs could be maintained in all cases in air or carbon dioxide, while in hydrogen, argon, and nitrogen, the arcs were either unsteady or would not strike at all. At lower pressures the arcs were less stable for all gases.

During some of the experiments, electrodes which had been used for arcs in air were found to give steady arcs later when used in argon. Further investigation showed that this phenomenon was due to oxidation of the electrodes when used in air, the same degree of arc stability being obtained in argon with electrodes oxidized by other methods. In addition it was found necessary to treat the cathode only; a stable arc could be maintained with a clean iron anode, and an oxidized cathode in argon and nitrogen, and also for a short time in hydrogen. With the electrodes reversed, that is, using a clean cathode and an oxidized anode, the arcs were unstable in these gases.

Further observation showed that when an arc was struck in various gases with the treated cathode, the cathode spot was established at the point where the electrodes had been in contact, and remained stationary; with the clean electrode this spot wandered so rapidly over the surface of the cathode that the arc soon broke. In order to investigate this characteristic further, a flat plate cathode was made, part of the surface of which was oxidized, the remainder being clean. When an arc was struck on the oxidized surface, it remained steady, but when struck on the clean surface it wandered as before but did not cross over on to the

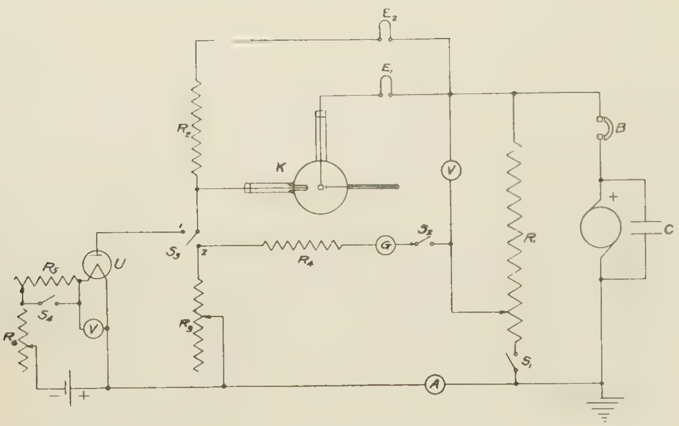

Fig. 2. Electrical equipment used in experiments on low-current arcs

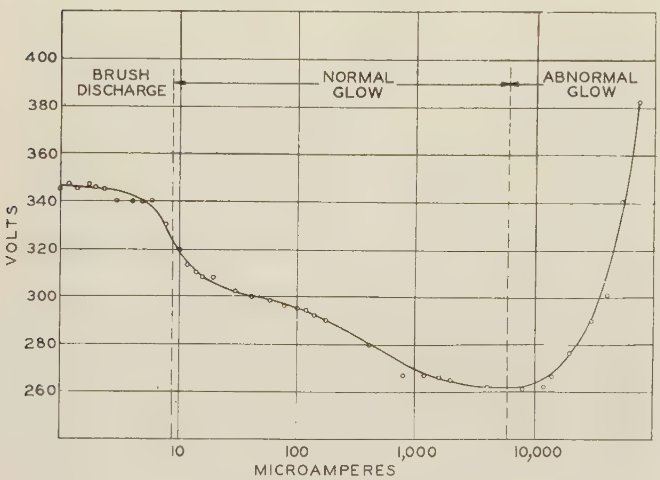

Fig. 3. Voltampere characteristic of the discharges preceding formation of the arc

2-mm. arc between copper electrodes in commercial argon under 2-cm. (Hg.) pressure

oxidized portion. On the basis of these tests the oxide seems definitely to prevent wandering of the cathode spot since other tests showed that this characteristic was not due to the roughness of the oxidized surface. This point is of particular note when it is considered that if the spot is prevented from wandering, the cathode temperature rises locally at that spot, and a steady arc results.

Tests in Dry and Moist Gases

In addition to the foregoing experiments, tests were made for the purpose of comparing arc characteristics in both dry and moist air and argon, respectively. Results of the tests in argon showed that the voltage drop across the arc in moist or argon was from 15 to 20 per cent greater than for the dry gas. Also the arc was found to be much more stable in moist than in dry argon especially at low currents, due perhaps to the oxidation which took place in the moist gas. Similar results were obtained for the tests in moist and dry air respectively, although the difference in arc drop was not quite so great.

The principal significance of the results of these particular tests is that if water vapor can be supplied to an arc used in welding the general effect would be to raise the potential drop of the arc, and thus for the same current increase the rate of melting.

To supplement the information already obtained, spectroscopic observations were made to determine which electrode contributed the greater amount of vapor to the arc stream. For this purpose a Hilger constant deviation glass spectrograph was used. Relatively low currents were employed for these experiments so that little or no fusion of the cathode took place. Results showed that the spectra in each case was typical of the cathode material although a few faint lines due to vapor from the anode were observed. The degree of excitation at the cathode thus is indicated to be much more intense than at the anode.

Transition Between Glow and Arc Discharges

In this portion of the study apparatus was arranged so as to enable the discharge characteristics to be observed between current values of 1 microampere and 2 amperes. A diagram of equipment used may be seen in Fig. 1, while Fig. 2 shows schematically the electrical connections. The arc chamber K consists of an 8-in. Pyrex bulb, electrodes being supported by the molybedenum rods R_1 and R_2 sealed in ground glass stoppers S_1 and S_2. To limit the area of cathode exposed to the discharge so that the region of the abnormal cathode glow might be explored properly, the cathode was made with two quartz protecting tubes C_2 and C_3, and with a large ribbed copper sleeve C_4 for cooling purposes. With this arrangement the cathode area exposed was about 0.22 sq. cm. The length of the arc gap was determined by a traveling microscope M with suitable scale, in conjunction with knife edge R attached to the rod of the soft iron plunger P. Glass beads B in the bottom of the bulb served to prevent drops of molten metal from cracking the glass. The heavy tungsten filament F serves to clear the bulb of all traces of oxygen in the argon.

For currents of from 1 to 100,000 microamperes switches S_1 and S_2 (Fig. 2) were closed. When the current values were such that the kenotron U was required, switch S_3 was in position 1; during those portions of the test in which the desired current variations could be obtained by external resistance S_3 was thrown to position 2. For currents from 0.05 to 5.00 amperes a UV-214 type kenotron was used, while for the lower currents a smaller three-element tube with grid and plate tied together was employed.

Arc-voltage readings were taken with various types of electrodes for currents varying from 1 microampere to 2 amperes. For this portion of the investigation observations were made on the galvanometer G.

Within this range of current it was possible to trace the development of the discharge from the corona or brush discharge through the normal glow and into the region of abnormal glow. A typical curve obtained from data taken in this manner for copper electrodes separated a distance of 2 mm. in commercial argon at 2-cm. (Hg.) pressure is shown in Fig. 3. Examination of this curve will reveal the fact that the volt-ampere characteristic is negative for the brush and normal glow discharges, becoming positive for the abnormal glow discharge. While the maximum voltage reached in the abnormal glow period varied somewhat an average value was of the order of 500 volts, and the corresponding current about 100 milliamperes. As the current was increased still further, the arc voltage decreased steadily until a drop of from 30 to 50 volts was reached, at which time the discharge exhibited all the characteristics of the true arc.

Due to the excessive heating of the cathode and of the protecting refractory material, difficulty was experienced in obtaining reproducible results within the transition region between abnormal glow and arc discharges. To overcome this difficulty, a large kenotron (UV-214 type) was employed for limiting the arc current, and an oscillograph was used to study the rapid changes occurring within this region, the two elements being connected as shown at E_1 and E_2 (Fig. 2).

To obtain the desired observations, the temperature of the kenotron filament was adjusted so as to give an arc current of about 2 amperes. The arc was then struck and switch S_4 (kenotron filament switch) was opened. As the filament temperature dropped, the arc current gradually decreased, the discharge passing through the various low-current stages. Oscillogram records were obtained simultaneously with this operation. Transition from the abnormal glow to the arc discharges was observed by starting with the normal glow discharge, then closing S_4, the kenotron filament switch; this gradually increased the arc current thereby causing the discharge to pass through the abnormal glow and into the arc stage, simultaneous oscillograph records being obtained as before.

A typical oscillogram showing the changes occurring between arc and abnormal glow is shown in Fig. 4 which was made with a short arc between copper electrodes in argon at a pressure of 25 cm. (Hg.). The duration of this experiment is indicated by the 60-cycle timing wave. In Fig. 5 is shown the volt-ampere characteristic plotted from the data given in Fig. 4. The transition from arc to glow was found to be quite abrupt. In other tests the transition from glow to arc was found to be practically identical and to take place at practically the same voltage and current values as the change from arc to glow. Since the time required for the kenotron filament to reach any particular value of discharge current must be different in the two cases, the transition would appear to be governed more by the cathode current density than by its temperature.

At lower pressures the transition between arc and glow was observed to be more gradual. This was true especially with short arcs. Thus it is quite obvious that both high pressures and long gap lengths tend to produce sudden transitions.

Results of these experiments indicate clearly the presence of a definite transition phase between the abnormal glow and arc discharges, although the volt-ampere characteristic for this stage is quite abrupt. Also current density at the cathode is shown to be the principal factor determining when this transition takes place rather than the temperature of that electrode. This contention is supported by other experiments in which the exposed area of the cathode was increased. In these, much higher currents were required before the arc could be developed, in spite of the fact that the electrode temperature occasionally was high enough to cause fusion.

An extension of this study of the transition from glow to arc and from arc to glow under various conditions appears to be a line of investigation which should lead to interesting results. An arrangement permitting the control and accurate measurement of electrode temperature especially that of the cathode, together with oscillograph records of the transition stages, should lead to a better understanding of the actual mechanism by which electrons are emitted from the cathode.

Fig. 4. Typical oscillogram for transition from arc to glow

1-mm. arc between copper electrodes in argon at 25-cm. (Hg.) pressure. Zero lines for voltage and current are indicated by V_0 and i_0, respectively

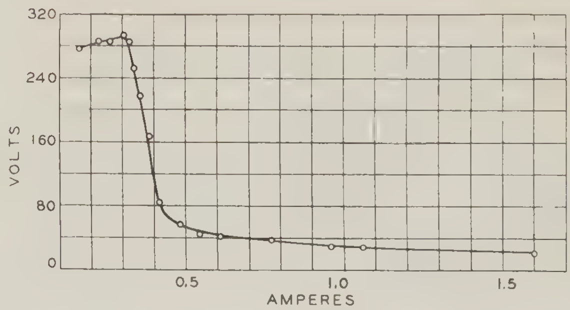

Fig. 5. Voltampere characteristic for transition period from arc to glow obtained from oscillogram shown in Fig. 4

Repulsion Starting for Capacitor Motors

The characteristics of single-phase motors are improved considerably by the addition of a capacitor winding on the stator. High torque and low current during starting also can be secured by the use of a repulsion type of rotor.

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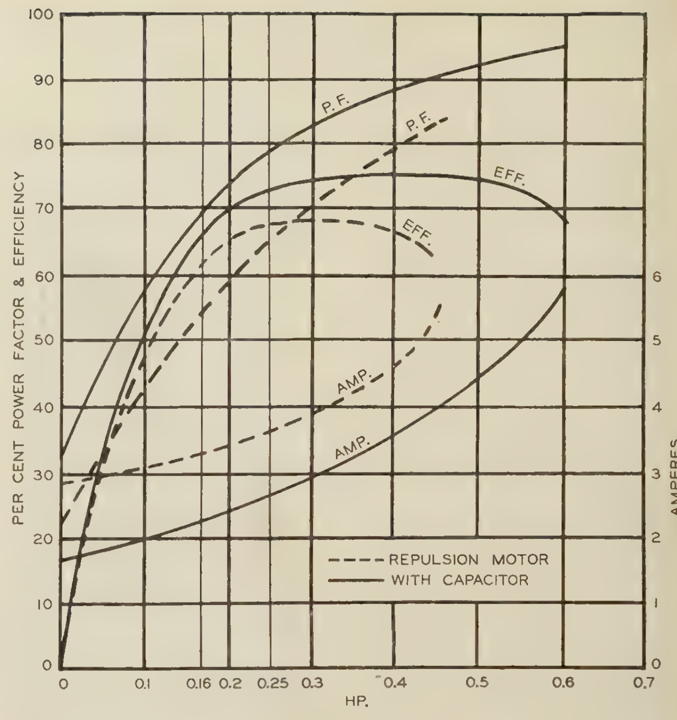
THE DEMAND for single-phase motors with better electrical characteristics, together with the development of reliable and inexpensive capacitors, has encouraged the use of the capacitor motor. The stator of this motor has a second single-phase winding connected in series with a condenser and energized from the supply line. With this form of single-phase motor it is possible to approximate the efficiency and quietness of a polyphase motor, and at the same time to improve greatly the over-all power factor.

The problem of starting capacitor motors is about the same as in the case of single-phase induction motors without capacitor winding. Two general methods are available; the split-phase or rotary-field method of starting with a squirrel-cage rotor, and the commutator or repulsion method, in which the rotor currents are commutated for starting, and are short-circuited at running speed to operate as a squirrel-cage motor.

In the capacitor motors so far developed, split-phase starting and a squirrel-cage rotor have been used. With this means it is possible to use the capacitor winding as the split-phase winding during starting. Where a fixed condenser and a squirrel-cage rotor provide efficient starting torque, and the starting currents are not objectionable, this split-phase method of starting is desirable. However, where the locked rotor and low-speed torque must be exceedingly high, and heavy starting currents are objectionable, the repulsion method of starting has a considerable advantage over the split-phase method. Accordingly, an investigation was made of the practicability of a repulsion-starting capacitor motor; that is, a motor starting by the repulsion method but having a capacitor phase-winding on the stator.

The stator of a 1/6-hp. standard repulsion-induction motor was rewound for capacitor operation; the repulsion rotor was used for starting and then when up to speed was short-circuited in exactly the same manner as with the standard repulsion-induction motor. As shown by the curves, this capacitor winding had the effect of increasing the efficiency, power factor and output of the motor. Due to the increased efficiency, the capacitor motor operated at the same temperature rise at ¼ hp. that it did as a 1/6-hp. plain repulsion-induction motor, corresponding to about a 50 per cent increase in output. Also, it tended to eliminate noise, combining the better running characteristics of the capacitor motor with the starting characteristics of the repulsion-induction motor. Repulsion starting provides the same starting characteristics for the capacitor motor that it does for the plain induction motor, giving high locked-rotor torque with low locked-rotor current.

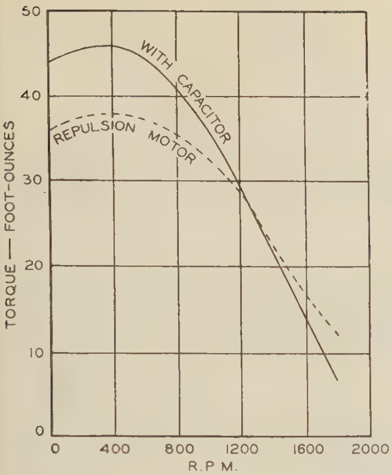


Characteristics of 1/6-hp. standard repulsion motor, and as rewound for a 1/4-hp. repulsion capacitor motor

Comparing a ¼-hp. repulsion-capacitor motor with a split-phase capacitor motor of the same rating, it was found that although the pull-out torque of the repulsion motor was less than that of the split-phase motor, and the full-load torques were the same, the locked-rotor torque of the repulsion motor was considerably greater. Also, the locked-rotor current and energy of the repulsion motor were reduced by more than half, and the full-load efficiency and power factor were increased.

Another advantage of the repulsion-capacitor motor is that a 7.5-μ f. condenser could be used in series with the capacitor winding for both starting and running, while the split-phase capacitor motor required a 7.5-μ f. condenser for running, and a 45-μ f. condenser for starting. In the event of condenser failure the repul-

Written especially for ELECTRICAL ENGINEERING. *Not published in pamphlet form.*



Speed-torque curve of standard repulsion motor, and with a condenser connected permanently in the capacitor phase

sion-starting capacitor motor can still be operated as a plain repulsion-induction motor. Further, the equipment is fundamentally more substantial and reliable, as no overvoltage or surge is imposed upon the condenser at starting.

Considering both squirrel-cage and repulsion motors, together with their condensers and accessories, there is some question as to which will be the more costly. In the repulsion-capacitor motor, the extra cost of the capacitor winding is not so great as in the squirrel-cage capacitor motor, as in the former the condenser is of small size and can be connected permanently in the circuit, eliminating any automatic cut-out or the switches required for starting with the split-phase method. Although the addition of a capacitor winding increases the cost of a motor, the fact that a smaller motor may be used for a given output will in part, at least, overcome this extra cost.

On applications where the starting conditions on single-phase motors are severe, the repulsion-capacitor motor has a decided advantage over the other types and should be practicable on all sizes of motors, from the smallest to the largest.

Distribution Systems for Industrial Plants

THE PLANNING of an electric distribution system for industrial plants may be divided into two distinct parts: (1) determination of the electrical characteristics, and (2) the physical arrangement of the system. Under these two headings W. J. McClain (associated with Louis T. Klauder, consulting engineer, Philadelphia, Pa.) discusses the problem in a very general way in a current A. I. E. E. paper.

In designing the physical layout of the system, the author points out that the plot plan of the plant, together with present and future building plans, should be studied carefully. The manufacturing processes and equipment set up in the plant also should be studied, and a digest of system requirements compiled in order to arrive at a satisfactory solution for any particular plant. Single-line diagrams with arrangement sketches should be drawn for comparative solutions, ranging from maximum economy of design to maximum reliability or continuity of service. These diagrams may be amplified to include such features as voltage regulation, power-factor correction, and various types of switching equipment.

In conclusion the author states that a comparative tabulation of different solutions should be compiled showing relative costs, losses, space requirements, special building construction, efficiency of operation, continuity of service, and maintenance. This comparative tabulation reduces the various solutions to a basis from which a final solution may be selected, or a compromise effected to include desirable features of any of the solutions considered.

From "Electrical Distribution Systems for Industrial Plants" (No. 31-29) presented at the A. I. E. E. winter convention, New York, N. Y., Jan. 26-30, 1931.

Electron Tubes for Industrial Control

ELECTRON TUBES have been in every-day use in radio and other communication fields for many years. It is only recently, however, that the field of application has been extended to include industrial usages, and while the gross number of industrial installations employing electron tubes is not enormous, important progress has been made in applying these new electrical tools to the problems of industry.

In a current A. I. E. E. paper, W. R. King of the General Electric Company, Schenectady, N. Y., outlines the fundamentals of operation and the practical aspects of the application of some of the more important of these new and interesting devices. Included in his discussion are the photoelectric tube, the three-element grid-controlled rectifier tube, and the grid-controlled mercury vapor rectifier.

From "Electron Tubes in Industry" (No. 31-50) presented at the A. I. E. E. winter convention, New York, N. Y., January 26-30, 1931.

News
Of Institute and Related Activities

"Vacation Convention" a Noteworthy Success

VIEWED from every angle the twentieth annual Pacific Coast convention held at Lake Tahoe, Calif., August 25-28, was notably successful. The official registration was 247, not a record so far as Pacific Coast attendance goes, but notwithstanding exceeding many a similar gathering held in "better times." All technical sessions were called to order on scheduled time and were exceptionally well attended; discussions were widely participated in. Golf, boating, water sports, mountain climbing, trout fishing, and trips to nearby points of historic or scenic attraction were participated in according to personal preference.

Fully half of those present were "on their own time," taking in the convention as a part of a family vacation trip. This feature is significant in several ways and well may serve as a guide-post to those planning future conventions.

The technical program comprised four sessions accommodating 17 papers prepared by 25 men. Such of these as were not previously published in ELECTRICAL ENGINEERING in comprehensive form were abstracted in ELECTRICAL ENGINEERING, September 1931, pp. 753-6, and hence will not be treated here. Some of these papers were of strictly local interest, while others were of wider general interest; all were well received. Several of the papers provoked extensive discussion, both extemporaneous and written. On pp. 835-7 of this issue may be found a comprehensive abstract of the salient points covered by such of these discussions as were submitted to Institute headquarters within the prescribed time limit.

Two sessions devoted to their papers and a student breakfast conference drew many Enrolled Students to the convention. Papers presented at these sessions included:

SHORT-CIRCUIT CALCULATION, C. L. Holmes, State College of Washington.

LABORATORY STUDY OF TRANSMISSION LINES, D. J. Moore, A. A. Petrick and D. D. Johnson, University of Washington.

RESIDUAL CURRENTS AND VOLTAGES IN POWER SYSTEMS, C. A. Bairos and G. S. Kimball, Stanford University.

EFFECTS OF SHORT CIRCUITS UPON THE STABILITY OF A TRANSMISSION SYSTEM, S. G. Winkler, University of Southern California.

INFLUENCE OF PRESERVATIVES ON THE DIELECTRIC STRENGTH OF WOOD, C. B. Parsons and M. H. Tipton, Oregon State College.

SOME ELECTRICAL METHODS OF GEOPHYSICAL PROSPECTING, F. M. Holly, Jr., Montana State College.

VACUUM-TUBE VOLTAGE REGULATORS, E. W. Palmrose, University of California.

THYRATRON INVERTER, G. A. Ross and L. W. Russell, California Institute of Technology.

THE REFLEX THERMIONIC VOLTMETER, L. W. Thorpe, University of Santa Clara.

ACOUSTICS OF KINGSBURY HALL, F. Lundberg and F. N. Neal, University of Utah.

TORQUE ANGLE CHARACTERISTICS OF SYNCHRONOUS MOTORS, W. F. Arndt, California Institute of Technology.

SOUND PICTURE SYSTEMS, Charles Douglas, University of Nevada.

C. E. Grunsky of San Francisco, Calif., president of the American Engineering Council, presented the feature address of the convention at a general session held the evening of August 26. Men and women alike paid close attention to this dissertation on "Business Cycles and Some Economic Problems" in which the speaker's penetrating insight and rare personality enabled him to present in a most interesting and illuminating fashion some of the fundamental causes underlying the recurring cycles of business activity. The speaker reviewed the situation rather comprehensively saying relatively little directly concerning the current economic disturbance, but pointing out the striking similarity existing between the current depression and those which have occurred periodically during the past century.

Having established the fact that history repeats itself so strikingly approximately every 20 years, Mr. Grunsky mentioned several important contributing factors including human shortsightedness and taxation inequalities, stressing the unfairness of our present political tax bonus system. He discussed also the rigid and destructive inflexibility of the dollar (or any other unit of money) as a measure of value where the element of time enters into a given transaction, presenting statistics revealing the varying purchasing power of the dollar (or any other money unit) during the past century. He suggested and strongly urged that with the present system of money as an exchange medium, and with a "commodity unit" to serve as a basis of evaluation supplementing the money unit, many evils now commonly encountered would be obviated. With the use of the commodity unit or "com" as a basis of valuation, the sale of services or commodities involving a period of time would be made on an agreed basis of so many "coms," thus assuring for buyer and seller an equitable deal. Payment of course, would be made in dollars or any other normal money unit according to the relation existing at the time of payment between the "com" and the money unit.

Of course, the principal sporting event was the annual golf tournament for the John B. Fisken perpetual trophy. Some 60 entrants enjoyed keen competition in three classes for the large group of valuable prizes. Honors for the day went to M. S. Barnes (M'31) of the San Francisco Section who by virtue of his low net score of 61 (78-17) captured the Fisken Trophy and a set of six matched irons. Others who shared in the prizes were G. R. Murphy (F'20), W. G. B. Euler (A'08), W. L. Winter (A'21) and Nathan Cohn (A'29) of the San Francisco Section; and C. C. Boozier (A'23) of the Portland Section. Kickers' prizes went to G. M. Rosenblatt (M'17) San Francisco Section; David Hall (F'18) Los Angeles Section; and C. C. Boozier (A'23) Portland Section. Honors in the women's putting contest went respectively to Mrs. A. V. Thompson and Mrs. A. G. Jones, San Francisco; Mrs. L. C. Williams, Los Angeles; and Mrs. D. M. Peterson, San Francisco.

The reception for President Skinner and the convention banquet constituted the two formal social affairs. A tremendously successful barbecue dinner held on the Tahoe Tavern tennis courts, and enlivened by the Neapolitan Trio of radio fame, introduced a series of informal social affairs very apparently enjoyed by all. The final event was "A Night in Monterey," a Spanish cabaret put on by the Tavern management.

Other entertainment features included a women's bridge tea, a three-hour steamboat trip down Lake Tahoe to scenic Emerald Bay, a presentation of Will Rogers's "Connecticut Yankee," and a playlet "What's the Use?" presented by local talent under the direction of A. C. Joy, San Francisco, depicting humorously the overthrow of a trained and established engineer by a correspondence-school graduate who had a diploma certifying to his mastery of engineering via a 90-day course.

President Skinner Traces Trend of Electrical Engineering

The convention was formally opened by General Chairman A. W. Copley promptly at 9:30 a. m. August 25, with a full attendance. Mr. Copley introduced Dr. C. E. Skinner, president of the Institute, whose opening address sketched, decade by decade, the trend of thought in electrical engineering as represented by the published record in the A. I. E. E. TRANSACTIONS. Excerpts from Doctor Skinner's address follow:

"The Institute's first meeting was held in Philadelphia in October 1884, and the first paper found in Vol. 1 of the TRANSACTIONS is by Dr. Edwin J. Houston on 'Phenomenon' now known as the Edison effect. . . It seems to me quite fitting that the first paper published should refer to work of Thomas A. Edison, the pioneer in incandescent electric lighting as well as in so many other fields.

"Curiously enough in this same volume is found a paper on a system for placing wires under ground and providing subways for electric traction under the streets of New York; another with the curious title 'The Earth as a Circuit Completer.' Attention is given to multiplex telegraphy and to electroplating; and very considerable discussion is recorded of the inadequacy of the patent office to deal properly with electrical inventions. I have heard this same discussion in recent years. In this discussion it is stated that prior to 1880 there were fewer than 2,000 patents recorded in the United States Patent Office having anything whatever to do with electricity.

1884–1890

"Subsequent volumes of the TRANSACTIONS between 1884 and 1890 contain some extremely interesting papers on various subjects. . . For example, in Vol. 4, 1887, appears a paper. . . 'Distribution of Electricity by Secondary Generators' outlining schemes with which my own more than 40-year career has been intimately associated. This paper was the announcement before the Institute of the a-c. system espoused by George Westinghouse and outlining the Gallard-Gibbs scheme of what we now know as the a-c. system of distribution by the means of transformers. . . Another paper which excited my interest, and some amusement, was a long paper, followed by a very extended discussion, on 'A New Arc Lamp Clutch.' It is also noteworthy that the men of prominence of that time referred to themselves and each other as 'electricians' and not as electrical engineers, and one wonders how it came about that the original name of our organization was chosen as the American Institute of Electrical Engineers. While I have not read carefully, I do not recall seeing the term 'electrical engineer' used in any of the volumes prior to 1890.

"The period from 1884 to 1890 was of course the real pioneer period of both the Institute and the electrical industry. It was a period of cut-and-try methods. The term 'industrial research' had not been coined, but even so, relatively great advances of this period can be assigned to relatively few experimenters, most of whose names appear in the Transaction of the Institute, and in many cases as past-presidents of the Institute. It was during this early period that the first limited electric light plants were installed and operated, and the electrification of street railways begun. . . A paper read in 1886 states: 'The central station of today is a very large and cumbrous arrangement. There are many engines in rapid motion and exposed to many dangers and interruptions. There is an air of gloom and anxiety on every face. The unseen tremendous power, not always under control, which is consumed at uncertain times and at invisible points, may be made to react at any moment with destructive energy.'

1890–1900

"The period between 1890 and 1900 was one of exceedingly rapid development and betterment in the design of electrical machinery, the means of measuring electric current, and the rapid extension of central stations and isolated electrical plants in buildings and factories. The TRANSACTIONS of the Institute reflect these advances and contain the fundamentals of the history of the electrical developments of the period. . .

"It was during this period that the great project of Niagara Falls came to fruition with the transmission of great amounts of power to more than twenty miles, and this was really the beginning of electric power as a commodity. The Tesla polyphase a-c. motor had been announced prior to 1890, but it was only during this decade that the polyphase motor became a commercial product. In the early nineties means of measuring alternating current were very unsatisfactory; the best instruments of precision we had for this purpose when I entered the Westinghouse laboratories were the Cardew hot-wire voltmeter and the Siemens electrodynamometer for current. However, much more satisfactory instruments appeared before the end of the decade. It was during this period also that the first high-voltage transmission plants were constructed in the West, the first of these being the so-called Pomona (Calif.) transmission at 11 kv.; and it is interesting to note that due to our lack of experience in the building of high-voltage transformers we used twenty 110/550-volt transformers with secondaries in series and primaries in parallel. The modern street-car motor in all of its essential principles appeared. . . in the summer of 1890. . .

1900–1910

"The next decade, from 1900 to 1910, was characterized by extremely rapid extension of electrical plants throughout the world, and the development of larger and more efficient electrical machinery. . . more efficient prime movers, particularly the steam turbine. . . It was the heyday of the street railway, and it was during this period that many important inventions. . . appeared. One of these which has had a profound influence was the development of silicon steel. Prior to the middle of this decade, electric steel was merely a refinement of the steel used for other purposes, and the losses particularly in transformers were giving a great deal of trouble. . . By the end of 1906 silicon steel, invented by Sir Robert Hadfield of England, was in general use both in this country and abroad, and the intrinsic loss had been cut in half and aging entirely eliminated. Many refinements and improvements have been effected since that time and much of the history of the magnetic art may be found in our TRANSACTIONS. Through the reduction of losses in electrical apparatus by the use of this steel hundreds of thousands of tons of fuel have been saved.

"One of the subjects which might be dealt with in a paragraph in any of the decades from 1900 to the present time is that of lightning protection. While I have not checked pages it is my belief that there are perhaps as many, possibly more, pages in our TRANSACTIONS devoted to lightning phenomena and lightning protection than any other single specific subject. . . It may be asserted, however, that. . . even in the beginning of the present decade, 1930 to 1940, the complete and final solution of lightning protection is yet to be effected.

1910–1920

"The period from 1910 to 1920 was a period of the further expansion of electrical plants, the further increase in the output and efficiency of electrical machinery, and the real beginning of the use of electricity in household devices and in industrial heating. The automobile had begun to take toll from interurban traction, and to a certain extent from city traction lines. In the previous decade electrification of the steam railways in congested areas had reached considerable proportions, and the old a-c.-d-c. battle was fought over again in connection with heavy electric traction. . . The mercury-vapor converter had entered as a factor, particularly in Europe, and at the same time the rotary converter had been brought to a very high degree of efficiency and perfection. . .

1920–1930

"The decade from 1920 to 1930 certainly may be characterized as the period of consolidation and interconnection. . . It may be of interest to note here that after a study of transmission made during my senior year in college (1889-1880) my class definitely proved that electrical transmission of light and power never would be profitable to a distance of more than five miles. We now transmit power by the a-c. system, then almost unknown, in very large quantities many hundreds of miles, and sooner or later we no doubt will be interconnected in our plants from the Atlantic to the Pacific. . .

". . . We are just as much interested, (and perhaps more so) in the future as we are in the past. Both the manufacturers and the utilities now have research departments intensively engaged in attempting to peer into the future, and in devising new applications, new materials, and new equipment. They are carrying on much fundamental research, many times with no immediate hope of commercial returns. . . It would be a bold prophet who would predict that radically larger units, more efficient prime movers, or better transmission systems would not be forthcoming; but for the present we seem to be more or less at a standstill in this line. The use of household devices is certainly on the rapid increase. . . One of the extremely interesting developments now going on is that of air-conditioning in our homes and offices, and even in our workshops and trains. . .

"I have not even mentioned some of the most sensational developments that have been made in fairly recent years, such as radio.

"We electrical engineers have been accredited, or perhaps accused of being responsible, along with other branches of engineering, for our present depression through our making it possible for the individual worker to produce much more than by older methods. It is certainly true that the machine age has brought us a host of problems that must be solved by us or by our children. As engineers we must go forward as we have in the past, bringing greater efficiency, greater comforts, more commodities, and greater production by the individual workmen. As citizens we must do our part in bringing the same sort of efficiency to our local state and national government. We must humanize our engineering. Surely some of the evils of today should yield to analysis and cure by the same general methods which have proved so effective in solving the multitude of far-reaching difficulties that have beset us as electrical engineers in the years compassed by our American Institute of Electrical Engineers.

Last Call for Kansas City Meeting

Kansas City, Missouri, host city to a three-day meeting of the South West District No. 7 of the A. I. E. E., has completed plans which will provide both a profitable and enjoyable time for those in attendance, October 22-24. Headquarters will be at the Kansas City Athletic Club.

Four technical sessions will be held during the meeting. These should prove of particular interest to the utility planning engineer as well as the utility operating engineer and all who are engaged in telephone communication work. In connection with the St. Louis-Bagnell interconnection session which will be held on Thursday evening, a three-reel motion picture of the actual construction of the Bagnell dam will be shown.

The local committee has arranged a variety of inspection trips to points of unusual interest embracing up to date electrical applications. Some of these features consist of new supersynchronous motor installations for the cement mills, the completely automatic distribution system of the Kansas City Power and Light Company, automatic installation of the Southwestern Bell Telephone Company, and the Bagnell water power project.

The chief social event of the meeting—the meeting banquet—will be held on Friday evening, Oct. 23. Entertainment will be provided by some of the best talent obtainable and following the banquet there will be dancing. Special plans have been made to care for women guests.

A detailed program of this meeting, together with a list of the papers to be presented, was published in ELECTRICAL ENGINEERING, September 1931, pp. 757-9.

District Executive Committees Meet at Tahoe

A business meeting of the combined executive committees of Districts Nos. 8 and 9 and the western portion of District No. 10 (Canada) was held at Tahoe Tavern, Lake Tahoe, Calif., August 26, 1931, as a luncheon gathering. Those present included: *president*, C. E. Skinner; *national secretary*, F. L. Hutchinson; *vice-presidents*, H. V. Carpenter and A. W. Copley; *District secretaries*, C. E. Baugh and R. D. Sloan; *Section chairmen*, E. A. Crellin (San Francisco), P. S. Biegler (Los Angeles); *other Section representatives*, W. C. Smith (San Francisco), H. W. Hitchcock (Los Angeles), O. B. Coldwell (Portland), C. B. Carpenter (Seattle), J. H. Hamilton (Utah), H. T. Plumb (Utah), F. W. MacNeill (Vancouver, B. C.), and J. A. Thaler (Montana).

The first order of business was the assignment of the 1932 Pacific Coast convention which was awarded to the Vancouver (B. C.) Section with the dates tentatively set as August 29-September 2 inclusive. The 1933 Pacific Coast convention was tentatively awarded to the Utah Section.

Student participation in future conventions was a subject which aroused thoughtful and active discussion. Based upon experience with the Lake Tahoe convention, E. A. Crellin, the new chairman of the San Francisco Section, strongly urged that for future Pacific Coast conventions the usual convention committees be augmented by the addition of a "committee on student participation." Mr. Crellin suggested that the duties of such a committee should include primarily (1) attention to the question of suitable housing for students in attendance at the convention, and (2) assisting in and coordinating the work involved in the handling of student sessions, the securing and advance circulation of student papers, and the stimulation of discussion at student sessions by the choosing of "key" men to start such discussions.

Student Activities Discussed at Lake Tahoe

At a student activities conference held in connection with the Lake Tahoe convention August 27, and presided over by G. L. Hoard, student counselor, University of Washington, Seattle, several problems pertaining directly to the conduct of these student conventions were discussed. Concurrent student sessions were considered undesirable. A motion was passed authorizing next year's committee to select student papers on a competitive basis (rather than by allotment to schools as at present) such competition to be effective only after each Branch had been given an opportunity to present one paper for consideration. Arising out of a discussion of the problem of getting student papers in in time for intelligent selection, a motion sponsored by the students themselves was put through, urging the establishment of a definite deadline date for student technical papers.

As a result of discussions pertaining to the several problems involved in publishing, or otherwise reproducing in some

reasonable quantity, the officially accepted student papers, it was suggested by several that either the student Branches themselves, or the educational institutions with which they were affiliated might provide the necessary finances for this work. Other questions discussed included ways and means of getting before high school students authentic vocational guidance information pertaining to electrical engineering courses, and possible methods of enhancing student interest and student participation in Branch activities.

Out of the fourteen student Branches of the Institute in Districts Nos. 8 and 9 and the western half of District No. 10, thirteen were represented at this student activities conference. Twelve of the student chairmen were present (representing all Branches except those at the University of Nevada and the University of British Columbia) and nine of the student counselors were present. Student counselors present included: F. O. McMillan, Oregon State College, S. G. Palmer, University of Nevada, O. E. Osburn, State College of Washington, R. H. Hull, University of Idaho, W. G. Angermann, University of Southern California, J. H. Hamilton, (for A. L. & R. Taylor) University of Utah, R. W. Sorensen, California Institute of Technology, L. E. Reukema, University of California, and E. F. Peterson, University of Santa Clara (Calif.). Student chairmen present included: M. R. Jones, Jr. Stanford University, R. C. Hansen, University of Utah, D. H. Hansen, Oregon State College, P. F. Hawley, University of Arizona, A. S. Koch, University of Washington, G. E. Gage, University of Idaho, H. T. Lambdin, Montana State College, D. H. Olney, State College of Washington, P. B. Lyons, California Institute of Technology, V. T. Johnson, University of California, M. C. Marshall, University of Southern California. and L. W. Thorpe, University of Santa Clara.

Summarized Review of Some Pacific Coast Convention Discussions

ONLY discussion submitted in writing in accordance with governing A. I. E. E. rules is summarized; complete discussion together with all approved papers will be published in the TRANSACTIONS. Abstracts of all papers presented at the convention and not previously treated in ELECTRICAL ENGINEERING, were given on pages 753-6 of the September issue.

Industrial Applications

G. B. Rosenblatt (San Francisco, Calif.) discussed the economic side of "Electric Power in the Wood Products Industry." He explained that increasing taxes on standing timber had caused an over production in lumber which allowed but little or, in come cases, no margin of profit. Therefore, in order to realize a profit the industry will turn toward an increased number of fabricating processes and more uses of the wood waste, both of which will result in a greater consumption of kilowatt-hours.

K. M. Patterson (East Pittsburgh, Pa.) also discussed this paper with special reference to the application of synchronous motors. He pointed out that in the sizes used in the lumber and paper industries synchronous motors usually represent a savings in first cost over other types of motors, with the additional advantages of high efficiencies and controlled power factor. He also explained that the development of full magnetic control with adequate protective features had kept pace with the improvement of motor characteristics.

R. O. Brosemer (San Francisco, Calif.) and J. L. Wright (Portland, Ore.) discussed this paper and pointed out that their experience based on a number of actual surveys made in typical sawmills in the Pacific Northwest indicated that electric power consumption varied from 45 kw. to 60 kw. per 1,000 board feet. Another point brought out by them referred to the possible inference in Table II that synchronous motors should be used for all main drives in modern sawmills, and induction motors only for secondary drives. Notwithstanding the advantages and improvements in synchronous motors they felt that due to their simplicity and usually lower first cost, there was still a legitimate field in induction motors for such main drives.

David Hall (Los Angeles, Calif.) discussed "Electrical Equipment for Oil-Field Operation" referring to the progressing evolution from steam to electricity. He told of recent improvements made by his company regarding mud-pump drive. These consisted of wound-rotor induction motors with permanent resistance and reactance in the rotor circuit, an arrangement which provides a motor which will slow down under increasing loads and actually stall before the pumps can be injured. He also explained that rotary drilling using a completely electrified rig of the Hild differential type recently successfully completed the deepest well in the world, drilled to a depth of 10,030 ft. He further explained that d-c. equipment was developed to meet the demand for drilling "wild cat" wells.

Electrical Machinery

P. L. Alger's (Schenectady, N. Y.) discussion of "Correlation of Induction-Motor Design Factors" was presented by J. H. Cunningham (Los Angeles, Calif.). Mr. Alger drew attention to the magnitude of the task and said that he believed it was theoretically possible and very desirable, to express all the electrical and mechanical constants of a motor, and also its cost, as explicit functions of its principal dimensions. Thence the optimum values of all dimensions could be determined for any desired evaluations of cost and performance.

R. E. Hellmund's (East Pittsburgh, Pa.) views on this subject were presented by David Hall. He pointed out that the designer usually is forced by many practical conditions to depart from the ideal, and that the author's method had the same limitations as all other methods of analyzing and carrying through design work by a simple set of formulas. If all essential considerations are taken into account, the method becomes cumbersome or else numerous assumptions have to be made which do not properly take into account all factors of practical importance. The second fundamental assumption in the author's theory used the ratio of the flux densities in the teeth and the core. Mr. Hellmund did not believe that the choice of this factor as an important variable was particularly desirable because this ratio did not represent anything very basic in the design of the motor. It can be, and frequently is, varied over wide limits without materially affecting the final results.

G. E. Creed and R. J. Thompson (Hamilton, Ont.) in their discussion of this subject which was presented by V. B. Wilfley (Portland, Ore.) called attention to several pertinent considerations including power factor (especially on slower-speed motors), iron losses, ventilation, proportion of length of coil ends to active length, starting current, starting and pull-out torques, and the necessity for using commercial wire sizes. They pointed out that these considerations usually would require an appreciable departure from the theoretically best dimensions which give minimum stator resistance in order to obtain a good practical design.

New Type of Truck for Line Crew

ADDED to the motor fleet of the Cleveland (Ohio) Electric Illuminating Company is a new unit which has proved so satisfactory that a second is being built. The vehicle is designated as a "tractor-type semi-trailer" and is constructed so that the trailer can be detached and left at the scene of an operation, while the tractor is free to engage in such transportation work as may be required. Its fully enclosed cab provides comfortable seats for twelve men, well safeguarded against traffic accidents. There is ample space within the body for all sizes of tools, the compartments being arranged so that the tools most frequently used are on the outside. The unit is of all-metal construction, sturdy and weatherproof.

A. H. Barth's discussion of this paper was presented by R. W. Sorensen (Pasadena, Calif.). It explained that the author has been given an opportunity by an electrical manufacturer to try his method of analysis in the laying out of new designs and adding larger sizes to older lines where the dimensions of the component parts could be made any value which would give the most satisfactory motor and not be governed by the necessity of adapting a particular motor to an existing frame. The author has been very successful in this work and the paper is the result of his having filled the need for a simple manner of determining optimum motor dimensions mathematically instead of by the rather empirical methods which now are in general use.

R. W. Sorensen also discussed this subject explaining that the Hoover analysis enables one in the early stages of design, to consider mathematically, and thus accurately, more of the variables which have to do with the relations between punching diameters both internal and external, core depth, and slot dimensions, thus reducing the element of guess work, and making possible a more accurate selection of the rating to which a given punching is best adapted.

E. A. Crellin and F. I. Lawson (San Francisco, Calif.) discussed "Calorimeter Measurement of Stray Load Losses on Generators." They analyzed test methods to determine stray load losses and presented data on generator losses obtained by the retardation method from efficiency tests made on a number of hydroelectric units. They cited that the information presented by the authors, giving an independent determination of stray load losses, was a distinct contribution to the hydraulic as well as to the electrical engineer.

Power Transmission and Distribution

J. W. Bennett's (Springfield, Mass.) discussion of "A-C. Networks in Portland, Oregon" was presented by G. Ross Henninger (New York). The discussion drew attention to the cost of the duplicate primary system adopted in Portland, as compared with the system having a radial primary and network secondary. The discussor cited several local conditions each of which would be variable in different localities, and stated that these of course would influence the design and development of a distribution system. He believed the difference in favor of the system adapted was due to conditions existing in Portland. Results of a recent comparative study made by J. W. Bennett were in favor of a low-voltage network system supplied at 13-kv. secondary transmission voltage for areas having a well distributed load of 5,000 kva. per sq. mi.

H. S. Fitch's (Pittsburgh, Pa.) discussion of "Tie Line Control of Interconnected Networks" was read by S. B. Clark. The discussion told of the operating problem of the Pennsylvania-Ohio-West Virginia interconnection from the early beginning up to the present time. Tie line control on this interconnection first was attacked from the point of view of frequency control.

Nathan Cohn (San Francisco, Calif.) presented Philip Sporn's (New York) discussion of this subject which reviewed the problem as related to the operation of interconnected systems. It was the experience of Mr. Sporn that automatic frequency control on each of two systems operating on parallel has been found to reduce greatly the fluctuation on a tie line, and in one instance it was the only practical means of operating the systems in parallel through a relatively weak tie line. This statement is contrary to the findings in the paper discussed.

P. B. Garrett (San Francisco, Calif.) presented a discussion prepared by John Gosinski (Jackson, Mich.) which drew attention to the operation of tie-line load regulators. It was pointed out that the purpose of an interconnecting tie line was to transfer large blocks of power in an emergency, and that any regulating device should preserve this feature of an interconnection.

Dr. W. A. Lewis (East Pittsburgh, Pa.) presented Robert Brandt's (Boston, Mass.) discussion of this paper which also brought out the necessity of frequency control as a step in the solution of the major operating problem. He believed the mechanical devices described in the paper had been well thought out and that they serve their purpose admirably. In particular, reference was made to the explanation of the anti-hunting feature which takes into account the momentum that has to be established and later destroyed in bringing the system from one load condition to another.

A discussion by Edith Clarke (Schenectady, N. Y.) on "Tuned Power Lines" was read by G. Ross Henninger. By means of vector diagrams, Miss Clarke arrived at the same results as those expressed by Professor Skilling in his paper, (that a transmission line of wave-length slightly over a half wave, including the terminal machine impedance, has good operating characteristics and that power may be exchanged between a synchronous generator at one end of such a line and a motor at its other end, while for the line slightly under a half wave-length little or no synchronous power can be transmitted).

Communication

G. T. Rouden (San Francisco, Calif.) discussed "Intercontinental Radiotelephone Service from the United States," explaining that the International system had a circuit in operation handling telegraph business between New York and Madrid via Buenos Aires. This avoids the difficulties experienced with an east-west circuit such as that over the North Atlantic. He also mentioned the downward trend in the cost of long-range antenna systems. The high steel tower construction used during and just following the war period now has been superseded by the simple double-V antenna supported by common wood poles only 70 ft. high. The new and less costly

construction provides efficient operation over a wide range of frequencies and is expected to make feasible the extension of communication facilities to many localities which otherwise could not be reached economically.

P. G. Caldwell (Stanford Univ., Calif.) discussed "Electrical Measurement of Sound Absorption," explaining that when sound energy is "absorbed," it is converted into heat energy by a process which involves a friction between the absorbing material and the oscillating air particles. Therefore sound-absorbing material will be most effective when it is placed where the air particles are oscillating with maximum velocity. This position always is a quarter-wavelength distant from a sound radiator or hard reflecting surface. The data in Fig. 5 of the paper are not in accordance with the foregoing explanation. Possibly one reason for the apparent discrepancy lies in the fact that the radiator was a dynamic loudspeaker. There is some question as to what point on the loudspeaker cone should be considered as a reference when taking data such as that in Fig. 5.

Electrophysics

H. H. Skilling (Stanford Univ., Calif.) discussed "The Kindling of Electric Sparkover" quoting similar conclusions from a report of a study made at the Ryan laboratory. These conclusions concerned superposed 60-cycle and impulse phenomena between points; they supported the three conclusions in the paper.

S. S. Mackeown (Pasadena, Calif.) discussed the theory of the spark discharge to show just what is difficult to understand today. He referred to the early theory of Townsend's and the work of Rogowski and others which found that the time necessary for a spark discharge to occur was of the order of 10^{-8} sec. He explained that the pictures in Doctor Magnusson's (Seattle, Wash.) paper were a record of what occurred probably of the order 10^{-5} sec. Therefore it would seem dangerous to draw conclusions regarding the actual formation of a spark from the data presented in that paper.

Radio Coordination

J. J. Smith's (Schenectady, N. Y.) discussion of this subject was presented by C. F. Green (Schenectady.) He cited several points which showed that the question of responsibility is more involved than would be assumed from the three last paragraphs in the section entitled "Responsibility" in the paper. He believed the work done by the authors would be of considerable value if carried out in a quantitative manner so that measurements in one locality could be compared with those in another.

J. O'R. Coleman (New York) interestingly discussed this problem and drew attention to the question of definition of interference as applied to radio. He referred to the study of the coordination of power and telephone systems, which revealed that the problem naturally divided itself into a study of power system influence, coupling between the two systems, and susceptiveness of the telephone system. He believed the same treatment could be applied in the handling of radio coordination. It was explained that a joint committee of representatives of the R.M.A., N.E.L.A., and N.E.M.A. had been formed to study the problem.

F. B. Doolittle (Los Angeles, Calif.) discussed this subject emphasizing the need for a better distribution of broadcast coverage in California. He showed a map of the state in which the areas enjoying reasonably good reception were designated and might be compared with the total area of the state. It was believed California had a sufficient allotment of broadcast power and frequencies to serve the area adequately, but that the geographical distribution of stations was not good. Reliable service is not available to large areas while inconvenience is worked upon other places by an excessive number of stations.

Nomination of 1932 Institute Officers

Actions specified in the Institute's constitution and by-laws relative to the organization of a national nominating committee are being taken, and the meeting of the national nominating committee for the nomination of officers to be voted upon at the election in the Spring of 1932 will be held between November 15 and December 15. All suggestions for the consideration of the national nominating committee must be received by the secretary of the committee at Institute headquarters, New York, not later than November 15.

The sections of the constitution and by-laws governing these matters are quoted below:

Constitution

28. There shall be constituted each year a national nominating committee consisting of one representative of each geographical district, elected by its executive committee, and other members chosen by and from the board of directors not exceeding in number the number of geographical districts; all to be selected when and as provided in the by-laws; the national secretary of the Institute shall be the secretary of the national nominating committee, without voting power.

29. The executive committee of each geographical district shall act as a nominating committee of the candidate for election as vice-president of that district, or for filling a vacancy in such office for an unexpired term, whenever a vacancy occurs.

30. The national nominating committee shall receive such suggestions and proposals as any member or group of members may desire to offer, such suggestions being sent to the secretary of the committee.

The national nominating committee shall name on or before December 15 of each year, one or more candidates for president, national treasurer and the proper number of directors and shall include in its ticket such candidates for vice-presidents as have been named by the nominating committees of the respective geographical districts, if received by the national nominating committee when and as provided in the by-laws; otherwise the national nominating committee shall nominate one or more candidates for vice-president(s) from the district(s) concerned.

By-laws

Sec. 22. During September of each year, the secretary of the national nominating committee shall notify the chairman of the executive committee of each geographical district that by November 1 of that year the executive committee of each district must select a member of that district to serve as a member of the national nominating committee and shall, by November 1, notify the secretary of the national nominating committee of the name of the member selected.

During September of each year, the secretary of the national moninating committee shall notify the chairman of the executive committee of each geographical district in which there is or will be during the year a vacancy in the office of vice-president, that by November 15 of that year a nomination for a vice-president from that district, made by the district executive committee, must be in the hands of the secretary of the national nominating committee.

Between October 1 and November 15 of each year, the board of directors shall choose five of its members to serve on the national nominating committee and shall notify the secretary of that committee of the names so selected, and shall also notify the five members selected.

The secretary of the national nominating committee shall give the fifteen members so selected not less than ten days' notice of the first meeting of the committee, which shall be held not later than December 15. At this meeting, the committee shall elect a chairman and shall proceed to make up a ticket of nominees for the offices to be filled at the next election. All suggestions to be considered by the national nominating committee must be received by the secretary of the committee by November 15. The nominations as made by the national nominating committee shall be published in the January issue of Electrical Engineering, or otherwise mailed to the Institute membership during the month of January.

Signed F. L. Hutchinson,
National Secretary

October 1, 1931

H. L. Doherty Finances Unemployment Research.—Press reports of September 9, 1931, recorded the statement that Henry L. Doherty (A'98-F'13) widely known public utility operator has made available to the American Society of Mechanical Engineers a fund of $500,000 to provide for a study of the present industrial situation and to work out ways of remedying it.

Annual Safety Congress to be Most Extensive

The twentieth annual safety congress and exposition under the supervision of the National Safety Council is to be held in Chicago, October 12-16, 1931. An impressive list of 130 sessions with more than 300 speakers has been assembled for this conference which is to cover all the various organized fields of safety work. The public utilities section is an important part and represents about 400 organizations with more than 900,000 employees. The meetings of this section are to be held on October 13, 14, and 15. Another important group is the electric railway section which holds meetings on the same dates.

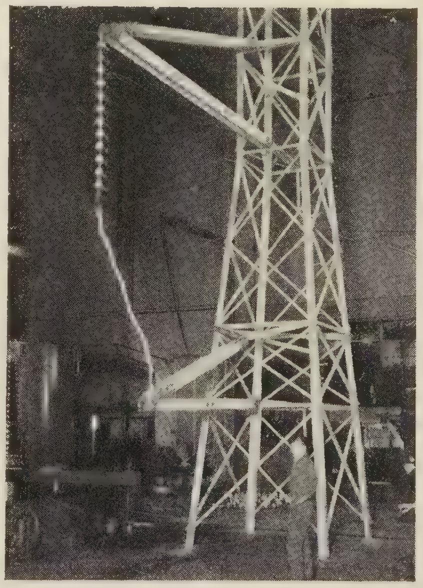
In addition to the sessions for specific industries there will be a number of special industrial sessions. Among these are sessions on industrial health and industrial psychology. One of the features of the congress will be the annual safety exposition in the large exhibition hall of the Stevens Hotel, where more than 100 exhibitors will display a panorama of standard safety equipment and the latest developments in safety appliances. This will be the most extensive and fully rounded safety congress ever held. It is significant that during these times of economy industrial safety activities have not slackened.

Executives to Visit Research Laboratories

A distinctive tour for industrial executives and bankers to important research laboratories has been arranged for October 5 to 15, 1931, under the auspices of the National Research Council. The purpose of the tour is to demonstrate the importance, value, and varied applications of research in industry, and by personal observation to study the operation and compare the different types of successful laboratories. The trip is similar to one made last year by a party of 100 selected industrial executives and bankers, and from which a number of very important by-products resulted.

The group will leave New York October 5 on a steamer for Boston; then continuing by train will visit research laboratories in the eastern part of the country. Dinners and accommodations have been arranged to insure the success of the trip. The laboratories to be visited are those of the Massachusetts Institute of Technology, Dewey and Almy Company, Arthur D. Little, Inc., Thompson and Lichtner Company, and the United Drug Company, all in Boston; the Eastman Kodak Company in Rochester; the Ford Motor Company and proving grounds at Detroit; Nela Park at Cleveland; Goodyear Tire and Rubber Company, and the Zeppelin Plant at Akron; the Basic Science Research Laboratories and Tanners Council at the University of Cincinnati, both in Cincinnati; Battelle Memorial Institute at Columbus; and the Westinghouse Electric & Manufacturing Company at East Pittsburgh. The executives of these laboratories are offering their fullest cooperation toward the success of the tour.

Indoor Tower Tests



SETTING a precedent for indoor lightning investigations, according to reports, the full-size section of 132-kv. transmission tower shown in the accompanying illustration recently was set up in the Westinghouse laboratories where 3,000,000-volt surges are available from an artificial lightning generator. The set-up was made to study the behavior of a wooden crossarm construction specified by the Union Electric Light & Power Company (St. Louis) for a new transmission line from its Osage plant to Rivermines station. During the test, Stone and Webster engineers found that it took 1,800 kv. to flashover the string of insulators when hung from the wooden crossarm, as compared to 1,100 kv. to flashover the same string with the usual steel supports. The man standing in the picture to show comparative sizes departed from the vicinity before the flash shown occurred.

Illuminating Engineers to Hold "Silver Anniversary"

Beginning October 12th, the Illuminating Engineering Society plans a four-day silver anniversary convention to be held at the William Penn Hotel, Pittsburgh, Pa. Reflecting in full measure the importance of the occasion, an outstanding technical program has been provided which has kept pace with the latest and newest developments in lighting practise and technique. A pre-convention meeting for central-station lighting service engineers will be held on October 12, and the Hon. James Francis Burke will give the address of welcome to the opening session on the morning of October 13. An architectural lighting session will be held that afternoon, and on the following day there will be a session on aviation lighting and an evening meeting which will include the conferring of honorary membership upon Dr. Elihu Thompson (Charter Member F'13-HM'28, and past-president) and Prof. André E. Blondel (A'05-HM'12). Lighting service and lighting practise sessions will be held on the following two days. Novel entertainment will feature the annual banquet and dance in the main ballroom of the William Penn Hotel on Thursday evening. Ideal golfing facilities will be available at the St. Clair Country Club. Special consideration is being given to women guests by a Committee appointed for this purpose. A. W. Robertson, chairman of the Westinghouse Electric & Manufacturing Company is chairman of the general convention committee.

Electrical Congress to be Held in Paris

The fifth meeting of the International Electrical Congress is to be held July 1932 in Paris, where the first meeting of this congress was held in the year 1881. Subsequent meetings were held in Chicago (1893) Paris (1900) and St. Louis (1904).

The purpose of the 1932 congress is to review developments of the last few years in electrical theory and practise, and to enact such rules and formulate such standards as may be of advantage to future electrical progress.

An American committee on organization has been appointed to arrange for the participation of technical and industrial organizations in the United States, and for the preparation of papers; it will welcome inquiries from persons interested in obtaining further information. The names of those serving follow:

E. W. Rice, chairman, General Elec. Co., Schenectady, N. Y.

G. K. Burgess, Bureau of Standards, Washington, D. C.

James Burke, Burke Elec. Co., Erie, Pa.

L. W. Chubb, Westinghouse E. & M. Co., E. Pittsburgh, Pa.

W. D. Coolidge, General Elec. Co., Schenectady, N. Y.

E. C. Crittenden, Bureau of Standards, Washington, D. C.

W. A. Del Mar, Habirshaw Cable & Wire Corp., Yonkers, N. Y.

Gano Dunn, 43 Exchange Pl., New York, N. Y.

L. L. Elden, Edison Elec. Illum. Co., 39 Boylston St., Boston, Mass.

L. A. Ferguson, Commonwealth Edison Co., 72 W. Adams St., Chicago, Ill.

A. N. Goldsmith, Radio Corp. of America, 570 Lexington Ave., New York, N. Y.

C. R. Harte, The Connecticut Co., New Haven, Conn.

D. C. Jackson, Mass. Inst. of Tech., Cambridge, Mass.

F. B. Jewett, American Tel. & Tel. Co., 195 Broadway, New York.

A. E. Kennelly, Harvard Univ., Cambridge, Mass.

C. O. Mailloux, 111 Fifth Ave., New York, N. Y.

J. H. McGraw, 10th Ave. & 36th St., New York, N. Y.

R. A. Millikan, Calif. Inst. of Tech., Pasadena, Calif.

I. E. Moultrop, Edison Elec. Illum. Co., 39 Boylston St., Boston, Mass.

F. D. Newbury, Westinghouse E. & M. Co., East Pittsburgh, Pa.

H. S. Osborne, American Tel. & Tel. Co., 195 Broadway, New York, N. Y.

Farley Osgood, 31 Nassau St., New York, N. Y.

F. W. Peek, Jr., General Elec. Co., Schenectady, N. Y.

Harold Pender, Univ. of Penna., Philadelphia, Pa.

M. I. Pupin, Columbia Univ., New York, N. Y.

L. T. Robinson, General Elec. Co., Schenectady, N. Y.

L. B. Stillwell, 11 West 42nd St., New York, N. Y.

N. W. Storer, Westinghouse E. & M. Co., E. Pittsburgh, Pa.

S. W. Stratton, Mass. Inst. of Tech., Cambridge, Mass.

Philip Torchio, New York Edison Co., 124 E. 15th St., New York, N. Y.

W. R. Whitney, General Elec. Co., Schenectady, N. Y.

Welded Rail Committee Reports Further Progress

Progress Report Number Seven of the Committee on Welded Rail Joints recently was received at A. I. E. E. headquarters from the Institute's representative in that body, Prof. D. D. Ewing (F'20) of Purdue University, Lafayette, Indiana. This report has been filed for reference in the Engineering Societies Library, 29 West 39th Street, New York, N. Y. The committee is sponsored jointly by the American Bureau of Welding (welding research department of the American Welding Society and division of engineering of the National Research Council) the American Electric Railway Engineering Association, and the United States Bureau of Standards. Its membership comprises a total of about 60 individuals, including way engineers of several of the larger street railway companies, representatives of manufacturers of welded joints and welding equipment, welding experts, scientists, and testing experts.

About $24,000 was contributed originally for use of the committee by the American Electric Railway Association, interested manufacturers and a number of the larger street railways. The Railway Association is acting as treasurer for the fund, expenditures being made upon authorization of the executive committee appointed from the membership of the Committee on Welded Rail Joints. The principal objective of the committee is to improve each type of welded rail joint rather than simply to make comparative tests of the relative merits of these joints.

Previous reports (Reports No. 1 to 6 inclusive) indicate past progress made by the committee. The present report includes a study of the heat effects of thermit welds on the adjacent rail material; the effect of preheating and postheating welded specimens and rail joints; additional repeated impact tests of joints; and a study of butt and fishplate joints made with the atomic hydrogen process. The report includes also a study of stresses and distortions due to the heat of welding of low-carbon to high-carbon plates by Prof. T. R. Lawson of Rensselaer Polytechnic Institute, Troy, N. Y., and a discussion of this study by William Spraragen (M'26) of the National Research Council, New York.

Architects Study Simplified Practises

Typical of the service which the division of simplified practise of the National Bureau of Standards is equipped to supply are the simplified practise recommendations which they are now placing in the hands of each member of the American Institute of Architects. This institute has been active in supporting the simplification movement since the government first sponsored this in 1921.

The architect, although a strong individualist, realizes the benefits and savings inherent in simplification and at the same time knows that his individuality and originality of design are not impaired when simplified building materials are specified. It is not intended that simplification should mean standardization but that the industries will voluntarily limit varieties of stock items to those for which there is a constant demand.

Each member architect is being supplied with a complete list of simplified practise recommendations and is being informed of opportunities to obtain complimentary copies of any of the recommendations listed. Similar service for other industries has proved very popular and effective. Edwin W. Ely, chief of the division of simplified practise, states that this same service will be extended upon request to other associations.

Non-Magnetic Watch.—A new nickel-steel alloy originated by Dr. C. E. Guillaume, a winner of the Nobel Award in Physics, permits making a watch with hairspring and balance wheel which cannot be magnetized permanently. The conventional watch with regulation steel hairspring and the usual type of balance wheel becomes so erratic after exposure to magnetic fields up to 360 lines per sq. in. as to be rendered useless as a timekeeper. Extensive tests show that even in a field of 3,600 lines per sq. in. the hairspring and balance wheel of non-magnetically equipped watches were stopped only while actually within the magnetic field, resuming operation immediately upon removal therefrom. Ordinary watches under the same magnetic influence stopped "dead" and would not run again until they had been demagnetized.—*Telegraph and Telephone Age.*

Meeting of Committee on Electrical Insulation.—The fourth annual meeting and conference of the committee on electrical insulation of the division of engineering and industrial research of the National Research Council, will be held at Harvard University, Cambridge, Mass., November 13 and 14, 1931. There will be three technical sessions with papers on the physics and chemistry of dielectrics and on recent progress in engineering research in the field of dielectrics as applied to the insulation of electric circuits. A dinner on Friday evening will be followed by a lecture dealing with recent advances in dielectric theory. Dr. J. B. Whitehead of Johns Hopkins University is chairman of the committee.

South American Congress of Electrical Engineers.—The first congress of electrical engineers in South America is to be held at Buenos Aires from July 4 to 11, 1932, under the auspices of the Asociación Argentina de Electrotécnicos.

School of Welded Building Design.— The opening of a school of welding design at Schenectady, N. Y., has been announced by the General Electric Company. Its purpose is to teach engineers, architects, and draftsmen, both in and out of its employ, the methods of designing welded buildings. The course requires approximately four weeks for completion, and can be adjusted to suit the needs of each individual. There is no charge for instruction, the only requirement being that the applicant be an engineer or have some training in structural design or experience in the design of riveted structures. The differences between the application of welding and riveting to steel frames will be taught. The subject will be approached from a scientific point of view based on studies and tests made by this company over a period of years.

Letters to the Editor

Has Man Benefited by Engineering Progress?

To the Editor:

Permit me to express my complete sympathy with the statements made by Mr. Dreher in his letter published in the September issue (of ELECTRICAL ENGINEERING, p. 766) commenting on Doctor Mees's article, "Has Man Benefited by Engineering Progress?" (ELECTRICAL ENGINEERING, Aug. 1931, p. 642).

It is well that engineers begin to appraise the advantages of rapid industrial progress as against the importance of the social, intellectual, and spiritual advancement of the human race. It seems that with the growth of mechanical appliances, the necessity for thought has almost disappeared. People go through life controlled by custom, prejudice, and superstition, working for their sustenance at some routine job that requires an infinitesimal amount of brain work and employing the balance of their time in some amusement or recreation that requires still less of intellectual effort.

However, I do not quite agree with Mr. Dreher in his statement that "For all this, engineers are as much to blame as educators, priests, and magistrates." Perhaps the guilt of the educators and magistrates may be comparable to that of the engineers, but surely the greatest blame rests on the priests and other religious leaders who are supposed to lead the way for the social and spiritual advancement of the human race. As Mr. Dreher says, "The inability of men to cast off superstition . . . is fraught with the gravest danger." Probably this inability is due more than anything else to the great power of our present religious leadership, a leadership which is founded entirely on ancient superstitions, to mold public opinion.

Apparently there is among engineers, as among most people, a great fear of antagonizing existing religions, as they are preached by their leaders, and of finding themselves ostracized if they express opinions that seem to run counter to those of the masses, of that "stupid and sadistic herd," to use Mr. Dreher's words. Is it not time for engineers, who are trained from their early youth to learn the truth and to have an open mind, to begin to be frank and outspoken in their valuation of the leaders in other fields?

Only by freeing the human soul and mind from these shackles of prejudice and superstition can we expect the improvement in the social and spiritual life of humanity without which our great mechanical progress is valueless.

It is held quite generally that human nature does not change; I am enough of an optimist to believe that some day our mechanical progress will be considered of less importance than our social progress, and that we shall have leaders in ethics, biology, sociology, psychology, psychiatry, etc., who will convince us that human nature can change for the better; who will show us the way to assist consciously in making this upward progress more rapid. This will be the time when these leaders will be respected and followed to a greater extent than are our modern priests.

There is no reason for not confessing faith in a theory of evolution which has for its goal an ideal human being, possessing within himself, besides the intellectual power that scientific and mechanical progress indicates, a human or spiritual power which will make him realize that only as he can help to improve or enlarge the human values of those with whom he comes in contact can he himself become of greater worth as a member of the human race.

Yours truly,

G. LOBO (A'01, F'12)

(Pres. & Treas., Kelvin Engineering Co., Inc., New York, N. Y.)

Concerning Voice Training

To the Editor:

I wish to offer comment upon some of the statements appearing in "Voice Training on a Scientific Basis," published in the September, 1931, ELECTRICAL ENGINEERING.

In order that the experience which may qualify me in making such comment may be known, permit me to say that my hobby is vocal music. Among the various instructors with whom I have studied, I might mention Dan Beddoe, nationally known concert and oratorio tenor, now with the Conservatory of Music of Cincinnati; and Italo Picchi, opera singer, formerly with the Metropolitan Opera Company of New York, now with the College of Music of Cincinnati.

Passing over the first and second paragraphs, which are introductory, the third paragraph I may say agrees precisely with my conceptions based on experience.

The fourth paragraph I also endorse with emphasis. It holds encouragement for the beginner—although some qualification of the statements may be made:

(1) It may be true that in certain cases physiological defects may be present; *e. g.*, a tonsilectomy not carefully done as to restriction in the area of cutting may impair a voice through interference with proper muscular action.

(2) A voice may be inherently not pleasing. I say this with hesitation, for although there is wide variation in individual timber or quality, so much depends upon the mental and emotional characteristics.

(3) Physical vitality is of considerable importance. (While a beautiful rendition of the work of "Violetta" in La Traviata might be made by some one who is "perpetually tired," a robust constitution would be an asset for the singing of the toreador song from Carmen—with encores. Probably it is simply a question of the energy required, both for the tone characteristics and demand upon endurance over a period of time. In other words, the quality of robustness is desirable in a singer; at least for certain work. Average health and vitality, however, are in general adequate, even for professional singing.)

My particular attention, however, has been arrested by the fifth paragraph. I should say definitely that the "lower register" covers the entire range of correct singing. The "register" or manner of tone formation should be uniform throughout the range used, the only difference in tones at different pitch being the naturally increasing pressure of breath as the scale is ascended. (Through exercise of control, lower tones may be sung "forte" and upper tones "piano"—but for a well-developed tone of consistent timber, the natural action will be as first stated.)

The singer's range is about two octaves (instead of three) for a well-developed voice. . . The falsetto or upper register tone is rarely used, and generally is untrained. It is a head tone, usually flat and unpleasing. We say it lacks resonance, but this may be due to inability to produce much vibrato on account of the different use of muscles and resonating cavities. A singer also is usually unable to make much of a crescendo on a falsetto note. Yodelling is the repeated transfer from natural to falsetto tone and the reverse. The falsetto is used by singers of repute occasionally for a pianissimo concluding note in a song, above the singer's natural range.

From a scientific standpoint, I should not take exception to any of the statements in the article except "The registers should be isolated and trained separately; only when fully developed should they be coordinated." From the practical point of view of the singer the value of this opinion is questionable.

I have the opinion that tremolo, or pitch variation, is a fault in singing technique. The author did not clearly define "tremolo;" and the statement that "The vibrato is the means for moving the voice correctly from tone to tone" does not seem to be consistent with his definition of vibrato nor my experience.

Much further scientific work might be done on the human voice, which might include:

(1) The relative contribution as resonators of the various head and throat cavities, and variation in relative volume of sound from nose, mouth, and external surfaces of head and neck.

(2) The possibility of beat notes between resonating cavities resulting in some vibrato without variation of muscular tension, as described in the article.

(3) A study of the transition in tone quality from an "open" to a "covered" tone. Mediocre singers habitually use a tone of one particular timber; the real artist varies the tone quality as well as the intensity and vibrato to suit the emotional interpretation.

(4) A common fault in singers is the incorrect tension of throat and soft, palate muscles. For the individual learning to sing, intelligent tutelage probably will be of more value than a scientific exposition of this subject.

(5) The reduction in range caused by fatigue—particularly the loss of lower notes.

Very truly yours,

CHARLES T. BUTTON (A'29)

(Sales Engineer, Holtzer-Cabot Electric Co., Cincinnati, Ohio)

The Engineer In Civic Affairs

To the Editor:

I was greatly interested in reading the article entitled "The Engineer in Civic Affairs," by J. Allen Johnson in the September issue of ELECTRICAL ENGINEERING (p. 727). The thought occurred to me that I could perhaps add my small bit to the question of solving this problem, due to the fact that I have mixed my engineering work with some public service, having served during my spare time as president of a village board of education for the past eight years, and as chairman of a village planning board for the last five years, during which time I was engaged also as engineer in the design of some of the largest electric power plants in the Metropolitan (New York) district.

Mr. Johnson divides the problem into two questions: (1) how to establish a high professional standing of engineers, and (2) how to establish a high standing of the engineering profession in public affairs.

In answer to question number one I should reply as follows:

It would seem that the rapid strides in engineering achievements during the past generation could not have been possible without the faith of the investing public in providing the necessary financial backing to carry out the ideas advanced by engineers, and the dependence of the public in general upon the skill of the engineer in looking out for public comfort and safety as exemplified in the immediate acceptance and use by the public of new developments as rapidly as they appear.

I should answer question number two as follows:

The question of establishing a high standing for the engineering profession in public affairs rests entirely upon the shoulders of the engineer. If the engineer who may be recognized as an outstanding figure in his profession will refrain from passing judgment on public problems until he has studied and analyzed them in the same manner in which he would attack an engineering problem, and then be prepared to back up his judgment with sound reasoning, the public soon would learn to respect such decisions and thereby bring credit to the profession. The engineer, however, in common with men in other walks of life, likes to have his vanity tickled by being asked questions on public affairs with which he is only remotely familiar, and feels that he must live up to his reputation by answering impromptu. He thereby falls into the trap of making statements, based on snap judgment, which appear ludicrous when broadcast in cold newspaper type.

Only when engineers come to realize that every time a more or less prominent member of their profession passes snap judgment on some outstanding public problem which cannot be solved off-hand, even by persons who have made a long study of such conditions, he thereby brings discredit to the entire profession in the minds of the public, then, and only then, will the necessary steps be taken to correct such conditions so that the profession as a whole can be placed in the position of high standing which it deserves.

As it is desirable that the engineering profession establish a high standing in its opinions on public affairs, the problem of creating such a standing should be attacked at the root. To obtain full and complete information on such problems it is necessary that individual engineers give up a portion of their time to gratuitous public service as suggested by Doctor Wickenden (and quoted by Mr. Johnson). It is only in this way that they can become thoroughly familiar with the thoughts and ideas of the people with regard to public affairs. With this information as a basis on which to work, local councils or committees on public affairs can be formed consisting of representatives of the various engineering organizations who are familiar with such problems through actual contact with the public.

Problems of local interest can be handled readily by these councils, but in order to cover larger problems, the work of the local committees should be coordinated by state-wide councils and, for national problems, through a national engineering council consisting of representatives of all the state councils.

Opinions on public affairs given by such an organization then would not represent the ideas of individual engineers on more or less unfamiliar subjects, but would represent the coordination of the thoughts and ideas of many highly trained minds conversant with the detailed aspects of each case. By means of a flexible organization of this type, consideration of public problems would be confined to the small group interested in local affairs or expanded to cover state or national issues as required to meet the particular case.

In conclusion I should add that in order to secure the confidence of the public in the opinions of the engineering profession in public affairs, there must be a realization among engineers that proficiency and success in their own profession does not of itself qualify them as authorities on public questions which are not of an engineering nature.

Very truly yours,
ROBERT BAKER (A'17)
(Chief Engineer, Thomas E. Murray, Inc., New York, N. Y.)

A Formula for Happiness

To the Editor:

While the following is perhaps a rather tardy comment on Doctor Mees's refreshing query, "Has man benefited by engineering progress?" (ELECTRICAL ENGINEERING, Aug. 1931, p. 642) it is an immediate discussion on the discussion itself.

Doctor Mees's question was directed to engineers, but the answers so far published have exhibited philosophic elasticity rather than the conciseness one associates with engineering expression. Carl Dreher (ELECTRICAL ENGINEERING, Sept. 1931, p. 766) introduces Schiller into the controversy, and my equally good friend Professor Jansky (ELECTRICAL ENGINEERING, Sept. 1931, p. 766) like Torquemada, would substitute *welfare* for *happiness*. Happiness may be "incommeasurable," but at least it is tangible, intimate, and real, while welfare is often artificial, and arbitrary, with no consistent economic meaning. The Inquisition pinched, burned, racked, and quartered in the fair name of welfare. . . .

The problem is fundamentally hedonistic, and though it cannot be expressed numerically on, engineering principles are violated by the equation:

$$H = \sqrt{\frac{a}{b} - \frac{c}{k}}$$

where the symbols consistently represent emotional factors: H happiness, a the capacity to make the most of potential happiness, b potential happiness, c potential evil, and k the capacity of society to resist evil. History and psychology seem to indicate that over the historical period this last factor has remained constant.

Potential happiness b incontrovertibly has been increased by engineering progress (in the form of) movies, trips around the world, Rolls Royces, private yachts, airplanes, theatres—a thousand luxuries. But it is doubtful if our capacity to enjoy these things a has kept step with their potentiality. On the other hand, potential evil c certainly has received an increment with every major scientific development. Hence, with k a constant, it is probable that the Grecian Helot had not merely "as good a chance" but a better chance "for happiness than most modern factory workers."

It will be observed that if the factor c/k becomes lager than a/b (as necessarily occurs in the case of great economic distress, such as war, depression, strikes and wholesale banditry) happiness H becomes imaginary. And if philosophic considerations must enter into the discussion, inspection of the equation will indicate that the highest attainable happiness is expressed by unity, a mathematical interpretation compatible with Utopian bliss or Schopenhauer's positivity of evil.

Sincerely yours,
ZEH BOUCK (non member)
(Consulting Engineer Flushing, L. I., New York)

Local Meetings

New York Power Group Opens Season With Talk on Cables

The Power Group of the New York Section will open the 1931-1932 meeting year on the evening of October 6 with a talk on "Power Cables—Development and Trends" by D. M. Simmons, chief consulting engineer of the General Cable Corporation.

Cable engineers have many choices regarding type of cable and insulating materials available for application to specific problems in the transmission and distribution of electricity, and Mr. Simmons will discuss their advantages and disadvantages. He will outline modern trends and show that present developments in the art, undreamed of a few years ago, make practical underground installations up to and including 220 kv. High lights of Mr. Simmons's talk will be emphasized with an interesting group of lantern slides.

In accordance with the established practise of the New York Section groups the meeting will be called promptly at 7:30 p. m. and will adjourn at 9:30 p. m. A

cordial invitation is extended to all who wish to join in the discussion. The meeting will be held in Room 1, Fifth Floor, Engineering Societies Building, 33 West 39th Street, New York, N. Y.

New York Communication Group to Resume Activities October 27

The opening meeting of the New York Section's Communication Group will be held on Tuesday, October 27, 1931, at 7:30 p. m. in the auditorium at the Western Union Building, 60 Hudson Street, New York, N. Y. The noted physicist of the Bell Telephone Laboratories, Karl K. Darrow, will discuss "The Flow of Electricity in Various Media." His treatment of the subject will be popular rather than technical and will be of interest not only to men associated with any phase of the communication industry, but also to all members of the Section. Although the meeting will adjourn at 9:30 sharp, there will be ample opportunity for general discussion.

Chicago Section Power Group Organizes for 1931-1932

The Power Group of the Institute's Chicago Section was authorized in 1929 by the Section's executive committee, for the purpose of providing more meetings relating to the generation and distribution of power than were permitted by the limited schedule of formal Section meetings. Meetings of the group since have been held in the rooms of the Western Society of Engineers, with an average attendance of approximately 125; some of these were designated as joint meetings sponsored by that society and the Chicago Section.

L. W. Smith of Sargent & Lundy has been elected chairman of the Power Group for the season 1931-32 and the work will be carried on under the supervision of the executive committee the other members of which are:

F. L. Reinmann, Midland United Co., vice-chairman; A. J. Krupy, Commonwealth Edison Co.; N. C. Pearcy, Byllesby Engg. & Mgt. Corp.; H. T. Eddy, Public Service Co. of Northern Illinois; Gordon Cavanagh, North American Lt. & Pr. Co.

Montana Section Organized

Authority to organize a Montana Section of the Institute with the entire state as its territory was granted at the meeting of the board of directors held June 24, 1931. This Section was organized recently with Bozeman as its headquarters; officers elected are: *chairman*, Prof. J. A. Thaler, Montana State College; *secretary*, H. Dale Cline, Mountain States Telephone & Telegraph Company, Bozeman; *additional members of executive board*, W. A. Boyer, Butte; J. C. Dow, Great Falls; and Rollin Kennard, Great Falls.

Future Section Meetings

Lehigh Valley

October 16, 1931—First meeting of 1931-1932 season. Recent Developments in Transformers, by H. V. Putman, manager, transformer engineering department, Westinghouse Elec. & Mfg. Co. Meeting to be held at Altamont Hotel, Hazleton, Pa.

Toledo

October 16, 1931—High Tension D-C. Transmission, by H. R. Summerhayes, General Electric Company; Electrical System Operation, by F. H. Dubs, Toledo Edison Company.

Past Section Meetings

Portland

Some Institute Problems, by C. E. Skinner, president of the A. I. E. E., and assistant director of engineering, Westinghouse Elec. & Mfg. Co, Also, motion pictures and lecture on Doctor Skinner's trip through the Orient. Dinner at the University Club preceded the meeting. August 18. Attendance 74.

Vancouver

Some Institute Problems, by C. E. Skinner, president of the A. I. E. E., and assistant director of engineering, Westinghouse Elec. & Mfg. Co. Doctor Skinner showed motion pictures which he had taken during his recent world tour. Dinner at the Georgia Hotel preceded the meeting. August 14. Attendance 33.

Personal

H. H. Barnes (F'13) of the General Electric Company, New York, N. Y., recently has been appointed a divisional chairman of the commerce and industry division of the Emergency Unemployment Relief Committee of New York City. Mr. Barnes will head the activities of the electrical industries in the division and will form a committee to conduct solicitations among individuals and corporations in the electrical field. The relief committee has been organized by business leaders to provide for New York's unemployed during the coming winter, and plans for coordinating the task of raising and distributing funds already have been announced.

L. M. Cargo (A'06) executive representative, Mountain States, Westinghouse Elec. & Mfg. Company, Denver, Colo., and recently elected president of the Electrical League of Colorado, was chosen a member of the League Council at the annual conference of electrical league managers held July 27-31, 1931 at Association Island, New York.

A. C. Streamer (A'10) for some years assistant director of sales, Westinghouse Elec. & Mfg. Company, East Pittsburgh, Pa., has been appointed sales manager of the company's diversified products department in which is grouped all Westinghouse equipment not specifically alined with transportation, central station or industrial activities.

W. S. Moody (A'06, F'12) consulting electrical engineer transformer department, Pittsfield, Mass. and for 43 years identified with transformer design and production for the General Electric Company, retired as of July 1, 1931, from active work. He however will retain in a consulting capacity his connection with the company.

W. S. Gifford (A'16) president of the American Telephone & Telegraph Company, New York, N. Y., and director of President Hoover's unemployment relief organization, has been elected to membership on the finance committee of the United States Steel Corporation to succeed the late George F. Baker.

Henry G. Wood (A'23–M'28) assistant manager of the northeastern division of Westinghouse Elec. & Mfg. Company, New York, N. Y. recently changed to become electrical engineer in the general sales department of the Worthington Pump and Machinery Corporation, Harrison, N. J.

A. D. Stephanus (M'28) special representative of Westinghouse Electric International Company, Oslo, Norway, a short time since removed to the company's London office, 2 Norfolk Street, Strand, London W. C. 2, England.

William Shuler (A'15–M'24) until recently electrical engineer for the Columbia Engineering & Management Corporation, Cincinnati, Ohio, has accepted a position with the Dayton Power and Light Company of Dayton, Ohio.

H. E. Stafford (A'13–M'25) electrical engineer, Provincial Paper Mills, Ltd., Port Arthur, Ont., Canada, has changed his position to one with Moss Mines, Ltd., Tip Top Spur, Canadian National Railways, Ont., Canada.

Theodore Bodde (A'19) of the engineering department of the General Railway Signal Company, Rochester, N. Y., has received appointment to professorship at Northeastern University, Mudken, China.

W. P. Hammond (M'20) engineer of generating plants, Allied Engineers, Inc., Birmingham, Ala., has been appointed engineer for the Atlantic district of his company, to succeed L. N. Blagoveschensky.

M. A. Thomas (A'31) who previously has been located at the University of Texas, now is connected with the New Mexico College of A. & M. in the capacity of assistant professor of electrical engineering.

H. S. Evans (A'08) who was manager of the industrial department, Denver division of the Vacuum Oil Company, Incorporated, has removed to the New York headquarters of the company.

I. K. Dortort (A'29) until recently electrical engineer at Camden, N. J. for the Brown Boveri Company, has removed to Milwaukee, Wis., to join the Allis-Chalmers Mfg. Company.

Robert Landis (A'22) designing engineer at Brown Boveri Company's Camden (N. J.) plant now has joined the Allis-Chalmers Mfg. Company at Milwaukee, Wis.

H. Winograd (A'26) electrical engineer for the Brown Boveri Company, Camden, N. J., now is identified with the Allis-Chalmers Mfg. Company, Milwaukee, Wis.

Leo N. Blagoveschensky (A'25) who has been serving in the capacity of district engineer of Allied Engineers, Inc., Atlanta, Ga., has resigned from this position.

Obituary

Harry Phillips Davis (A'01, M'01) vice-president and director of the Westinghouse Electric and Manufacturing Company, chairman of the National Broadcasting Company, and one of the country's foremost engineers and executives, died at his home in Pittsburgh, Pa., September 10, 1931. He had been ill for several months, and at the time of his death was sixty-three years old. He was born at Somersworth, N. H., and was graduated with the degree of bachelor of science from Worcester Polytechnic Institute, from which in 1930 he received also the honorary degree of Doctor of Engineering. For more than 21 of the 40 years he was connected with the Westinghouse Company, he had charge of the company's engineering department; for 15 years, he directed its engineering and manufacturing operations. In 1911 he was elected a vice-president. Among his early achievements was his work in the electrification of the New York, New Haven and Hartford Railroad, the world's first single-phase railway electrification and a phenomenal engineering feat. His ability penetrated not only all phases of this electrification but many others that followed it. He was a man of indomitable energy, initiative, and vision, and his career was one of wide achievement. Nearly eighty electrical patents have been issued to him, and under his leadership many of the most important advances in the electrical art relating to meters, measuring instruments, circuit breakers, railway control, transmission, and radio, have been made. His foresight was perhaps most clearly demonstrated in the starting of the first broadcasting station; at a time when the public, and engineers as well, were looking upon radio quite definitely as a means of private or point-to-point communication, Mr. Davis envisioned it as a public service over a wide area and one to which everyone might listen. That was the birth of radio broadcasting, and by Mr. Davis it was looked upon as a public trust. With the success of the first station, November 2, 1920, he quickly placed others in service, thus establishing what may well be termed one of the greatest developments of the century. He was active in every phase of radio, and at the time of his death was known internationally as the "father of radio broadcasting."

Mr. Davis was director of more than a dozen corporations, among them the Westinghouse Electric International Company, Automatic Gear Shift Company, the Radio Corporation of America, R. C. A. Photophone, Inc., Radio-Keith-Orpheum Corporation, R. C. A.-Victor Company, Inc. He was also a vice-president of the Turtle Creek & Allegheny Railroad Company, and held membership in many engineering and scientific societies, the University Club of Pittsburgh, the Pittsburgh Athletic Association, and the Oakmont and Edgewood Country Clubs.

Edward James Condon (A'12, M'21) president of the Condon Engineering Company and General Power Company of Chicago, Ill., died suddenly August 25, 1931, of heart disease. He was 69 years old, having been born in Cambridge, Mass., and educated in the Boston public schools. He first became interested in engineering and utility work in 1893, and in association with several others accomplished a number of water and sewer contracts for the city of Chicago. In 1896 he directed the building of a reservoir on the southern slope of Pike's Peak for the city of Cripple Creek, Colo. The following year he returned to Chicago as a member of the firm of Cleary & Company, doing municipal work constructing water works, and gas and electric plants. As early as 1905 he became interested in several small electric plants, rebuilding some of them into an interconnected system in northeastern Indiana and southern Michigan. In 1924 these latter properties were bought by the Midland Utilities Company. Concurrent with his ownership and management of the Condon Engineering Company, he became president, general manager, and part owner of the Minnesota Electric Light & Power Company and the Eastern Montana Light & Power Company; still later he was elected to the vice-presidency and

general management of the Inter-Mountain Railway, Light & Power Company, operating in sixty cities and towns in twelve states. In 1925 he became president of the General Power & Light Company, but in 1929 disposed of all of his utilities properties and devoting his entire time to the Condon Engineering Company. His friendly personality won for him a wide acquaintance, not only among the men of all ranks in professional and the utility fields, but in fraternal organizations as well. He was a past-president of the Indiana Electric Light Association. He was always active at technical conventions; and was a member of the Western Society of Engineers, the Art Institute (Chicago), and Knights of Columbus.

Edward Otto Zwietusch (A'22) general manager of C. Lorenz A. G., was killed in an automobile accident August 8, 1931. To German industry his death represents the loss of an exceptional organizer. An American by birth (Milwaukee), January 20, 1866) he attended the University of Wisconsin at Madison. In 1886 he entered the employ of the Western Electric Company, and there received a practical knowledge of telephony, then in its infancy. This knowledge he utilized by going to Berlin in 1888 and founding the Telephon-Apparat-Fabrik. In untiring effort, he invented many new methods of telephony which were immediately adopted by the Reichspost. Charmed with the country of his ancesters, Mr. Zwietusch in 1904 became a German citizen, until 1921 conducting his business in Salzufer; then be became the representative of the Western Electric Company with the International Standard Electric Corporation, a position which he held until 1926. In January 1927 he was appointed General Director of the Vereinigten Telephon und Telegraphenfabrik, A. G. Czeija, Nissk & Company, Vienna. At the completion of this work early in 1930 he undertook the management of the Telephonfabrik Berliner A. G. in Berlin-Steglitz, remaining until accepting his recent position. Mr. Zwietusch was a man of few words, but he studied every problem thoroughly not only from a theoretical point of view, but a practical business angle as well. He was a man much beloved by his co-workers and esteemed by all with whom he had business dealings.

Donald Fairfax Whiting (A'18, F'30) since January 1930 technical director and chief engineer of the Fox Hearst Corporation of New York City was killed in an accident on September 8, 1931. He was born in Lowell, Mass., April 13, 1891, and graduated from Worcester Polytechnic Institute in 1915, receiving his E. E. degree in 1922. He was licensed as an electrical engineer by the University of the State of New York in 1927. In 1916 he entered the special research department of the Western Electric company, and in 1925 was made supervisor of the apparatus development department of the Bell Telephone Laboratories. Two years later he became staff engineer in charge of testing and research for the Fox Hearst Corporation and in 1929 was promoted to direction of the work. In each of these affiliations, Mr. Whiting evidenced rare inventive genius. He was a member of the Institute of Radio Engineers and of the Society of Motion Picture Engineers; and a fellow of the Radio Club of America and of the American Association for the Advancement of Science. At the time of his death he was still active on the following committees: membership, Radio Club of America; papers, Radio Club of America; projection, Society of Motion Picture Engineers; and committee on standardization of the Institute of Radio Engineers.

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the address as it now appears on the Institute records. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Balaguer, Manuel M., c/o International Tel. & Tel. Co., 67 Broad St., New York, N. Y.

Bunce, Lewis I., Rocky Hill, Conn.

Clark, Bernard, 79 Jenness St., East Springfield, Mass.

Cole, Will G., Box 222, Westwood, Calif.

Farnlof, Charles G. T., 1318 Laketon Road, Wilkinsburg, Pa.

McLean, James S., 190 Old Army Road, Scarsdale, N. Y.

Melson, Sydney W., Yeatton Woolwich Road, Abbey Wood, London, S. E. 2, England.

Mountain, C. E., Burma Elec. Supply Co., Mandalay, Burma, India.

Parr, J. C., 245-71st Street, Brooklyn, N. Y.

Pistorius, L. H., 193 Jeppe St., Johannesburg, South Africa.

Prudham, W. M., 100 Biddle St., Wilkinsburg, Pa.

Schrock, John E., 3720 Main St., Lawrence Park, Erie, Pa.

Stempfle, Frederick, 8126 E. Vernor Highway, Detroit, Mich.

Tate, William, Apartado No. 41, Publa, Mexico.

Voronovsky, T. G., 1162 Waverly Place, Schenectady, N. Y.

Test Code for Transformers

In the early part of 1929 a proposition was placed before the standards committee of the Institute, looking to the development of test codes for electrical machinery and apparatus. After a careful survey to obtain the reactions of key men in the manufacturing and electric power fields, the committee decided to proceed, covering for the time only the development of codes for the more important types of apparatus, such as generators, motors and transformers. This procedure was approved by the board of directors in May 1929. The standards committee then asked the electrical machinery committee to undertake the work, and at the meeting of July 23, 1931, the first report from the electrical machinery committee covering the "Test Code for Transformers" was received.

In order that the electrical industry might become fully cognizant of the work undertaken and at the same time be given a clear picture of just what it was contemplated to include in such test codes, the standards committee recommended to the board of directors that the "Test Code for Transformers" be made available to industry as a pamphlet published under the auspices of the electrical machinery committee. This suggestion was approved at the directors' August meeting, and the work of publication is now under way. Notice of the availability of the pamphlet will appear in a later issue of Electrical Engineering.

Engineering Foundation

Bequest of Edwin H. McHenry

United Engineering Trustees, Inc., has been made residuary legatee of the estate of Edwin H. McHenry of Ardmore, Pa. The estate is believed to amount to $225,000. Mr. McHenry died August 21, 1931. He was a member of the American Society of Civil Engineers. At one time he was receiver of the North-

ern Pacific Railway Company, and vice-president of the New York, New Haven & Hartford Railroad at the time when the electrification between New York and New Haven was undertaken; later he carried on a consulting practise. During his connection with the Northern Pacific Railway he was associated with the late Edward Dean Adams, through whose influence he made a small provision in his will for The Engineering Foundation. This he later changed to provide essentially that United Engineering Trustees, Inc. should receive the entire estate after the death of four beneficiaries who are to receive the income of the estate during their lives. Upon their decease, the entire principal of the trust estate is to be conveyed absolutely in fee to United Engineering Trustees, Inc. for The Engineering Foundation. Mr. McHenry makes this fund for research a memorial to his wife, Blanche H. McHenry, who died some years ago.

Standards

Several Projects Referred to New Committee

During July, approval of the new electrical standards committee was obtained from the eleven organizations of which it will be composed. This new committee supersedes the present electrical advisory committee of the American Standards Association, and will serve as a central agency in furthering the standardization work of the electrical industry. To this end all methods of procedure now recognized by A. S. A., as well as all powers for the formulation of standards, have been concentrated into one body, a new development initiated by the A. I. E. E. Resolutions transmitting it to A. S. A. were approved in January 1930 by the Institute's board of directors; steps are now under way for consolidating the work of the new committee with that of the U. S. national committee of the International Electrotechnical Commission. Detailed statement of this new development in electrical standardization was included in the August 1931 issue of the Bulletin of the A. S. A. which is obtainable from P. G. Agnew, secretary, A. S. A., 29 West 39th Street, New York, N. Y.

At the July 23rd meeting of the A. I. E. E. standards committee, action was taken recommending that several standards projects be referred to the new committee for disposition. These actions, subsequently confirmed by the board of directors, were:

1. Report No. 16, Railway Control Apparatus. This is a proposed revision of the present Institute and American standard on the same subject.

2. Standard No. 13, Transformers, Induction Regulators and Reactors. This is an Institute standard only, and reference was accompanied by suggested revisions.

3. Pamphlet No. 100, Recommendations for the Operation of Transformers.

4. Sixty-cycle Test Voltage for Transformers. This matter has been before the electrical machinery committee and there is a difference of opinion regarding its proper disposition.

5. Standard No. 12, Constant-Current Transformers, an A. I. E. E. standard since May 1930.

6. Report No. 18, Capacitors. Since May 1930 this has been a report on a proposed standard.

American Standards for Wood Poles Approved

For some time a sectional committee under the sponsorship of the telephone group of the American Standards Association and representing 23 organizations including the A. I. E. E., has been at work on the development of standards for wood poles. Already eight such standards have received the approval of the A. S. A., each standard covering ten classes of poles. These standards are available in four pamphlets dealing respectively with dimensions and specifications of (1) northern white cedar poles, (2) western red cedar poles, (3) chestnut poles, and (4) southern pine poles. These pamphlets are available at 20 cents per copy from the American Standards Association, 29 West 39th Street, New York, N. Y.

Relay Standards Report Available

A pamphlet, "Report on Standards for Relays" (A. I. E. E. standards report No. 23) is now available for suggestion and criticism. This report was prepared by a subcommittee of the A. I. E. E. standards committee under the chairmanship of George Sutherland of the New York & Queens Electric Light and Power Company; copies may be obtained free of charge from H. E. Farrer, secretary, Standards Committee, A. I. E. E., 33 West 39th Street, New York, N. Y.

The report deals with relays and relaying devices for the protection and control of apparatus and circuits for the generation, transmission, conversion, distribution and utilization of electric power. It does not include telephone, telegraph, traffic signal relays, or similar devices. The subjects covered are: service conditions, definitions, ratings, heating, limitations other than heating, dielectric tests.

New Standard Regulations for Signaling Systems

On recommendation of the National Fire Protection Association's committee on signaling systems, the regulations on protective signaling systems have been revised and divided into two separate pamphlets. The new regulations became effective September 15, 1931, displacing the former regulations on protective signaling systems, edition of 1929. The new pamphlets cover regulations for the installation, maintenance, and use of "Proprietary Auxiliary and Local Systems for Watchman, Fire Alarm, and Supervisory Service," and "Central Station Protective Signaling Systems for Watchman, Fire Alarm, and Supervisory Service." For further information and copies of pamphlets, address National Board of Fire Underwriters, 85 John Street; New York, N. Y.

Safety Code for Coal Mine Transportation

A safety code covering all phases of coal mine transportation recently has been approved by the American Standards Association as recommended American practise. The code deals with transportation on level and inclined tracks both underground and in mine yards; also haulage by motors, animals, or men. Complete systems of signals and safety rules are included. This work carried on under the sponsorship of the American Mining Congress has been in progress since 1924. Orders for the code may be placed with the American Standards Association, 29 West 39th Street, New York, N. Y.

New National Safety Code for Elevators

A new national safety code for elevators, dumbwaiters and escalators, recently has been approved by the American Standards Association. Developed under the sponsorship of the American Society of Mechanical Engineers, the American Institute of Architects and the U. S. Bureau of Standards, the revised code represents the result of nearly four years of research. For the first time, the code permits the operation of more than one elevator in a single shaft and also, provides for two-story cars serving two floors simultaneously. All communications relative to the code should be addressed to the American Standards Association, 29 West 39th Street, New York, N. Y.

Employment Notes

Of the Engineering Societies Employment Service

Position Available

SALES ENGINEER, 21 or 22, unmarried, to act as office engineer and secretary with manufacturers' agents sales office selling transmission and high-tension equipment for the New England States. Apply by letter giving complete information as to past experience, references and salary expected. Location, Boston. W-3080.

Men Available

TECHNICAL GRADUATE, 21, B. S. in E. E., 1931. Interested primarily in position offering stability, opportunity. Licensed broadcast class radio operator; two years' experience, operation and maintenance at 5-kw. station and general radio communication work. Prefers radio, telephone communication fields with work in laboratory, engineering department. Location, immaterial. Available immediately. C-9725.

ELECTRICAL ENGINEER, technical graduate, G. E. Test. Over 18 years' experience, including electrical manufacture; railway construction, valuation and maintenance; power line construction and steam railroad electrification. Desires position with company doing consultation and construction engineering or with operating company. B-7456.

GRADUATE ENGINEER, 22, single, B. S. in E. E., 1931. Two years' experience with public utilities in distribution and grounding work. Location, immaterial. C-9739.

ELECTRICAL-CIVIL ENGINEER, 27, married, university graduate. Desires position anywhere with public utility or contractor. Three years as sales and service engineer for electrical machinery manufacturer, specializing in synchronous equipment. One year as electrician on station construction. Two years varied civil engineering, including compressed air and rock-tunnel construction. C-4885.

ELECTRICAL AND CHEMICAL ENGINEER, 43, A. B. and B. S., executive experience in manufacturing and research; also public relations. Very successful in combating adverse publicity. Considerable experience in study of toxic gases. Available immediately. B-200.

COLLEGE GRADUATE, 23, single, B. S. in E. E., 1931. Desires work. Best of references. C-9747.

GRADUATE ELECTRICAL ENGINEER, 22, single, Lehigh University, 1930. Nine months' experience in the plant department of the American Telephone and Telegraph Company. Desires position with manufacturing concern or public utility. References furnished on request. Location, immaterial. C-9748.

PATENT ATTORNEY, 37, mechanical electrical engineer, independent reliable worker, broad, domestic, foreign experience acquired in research, industrial teaching, responsible engineering positions, five years with corporation patent department, now almost three years with large patent law firm, versed in foreign languages, growing clientele, desires connection with firm, attorney seeking competent intelligent cooperation. References available. C-9762.

RELAY AND CONTROL ENGINEER, 30, graduate McGill, location, Canada. Experienced planning protective circuits, automatic and supervisory controls. Familiar with equipment of generating stations, use of laboratory facilities and field engineering methods. Experienced on communication, amplifiers, photoelectric cells and maintenance of highest standards in associated circuits. Proven ability in personal contact. C-4668.

DESIGN ENGINEER, 27, technical graduate, 7 years' experience. Desires position with manufacturing firm. Experience covers: power station and substation design, production design of radio accessories, machine and tool, cemented tungsten-carbide development, power and conveyor equipment of nitrate plant. Good theoretical and practical background. Location, East. Available at once. C-4382.

GRADUATE ELECTRICAL ENGINEER, 33, married, B. S. in E. E. Eight years' experience in engineering work. Supervising design and construction of plant distribution, economic studies and cost estimating, public utility. Also sales engineering and contact work for manufacturing concern. Desires position with manufacturer, industrial concern or public utility. Location, United States. B-5858.

ELECTRICAL DESIGNER, 38, married. Fourteen years' public utility experience, five different corporations, power plant, switching station, substation, both indoor and outdoor. Desires connection with public utility or industrial organization. Available now. Location preferred, East. C-8490.

ELECTRICAL ENGINEER, graduate Georgia Tech., 1930, cooperative plan. Westinghouse lighting courses. Cooperative work, alternate months, five years in substation maintenance and office engineering. Rebuilding transformers, switches, lightning arresters, work with electric furnaces, rectifiers, meters, motors, etc. Checking and mapping distribution systems, work orders, drafting, etc. Excellent references. Perfect health. Location, immaterial. C-7847.

GRADUATE ELECTRICAL ENGINEER, 38, married. Sixteen years' experience in electrical engineering work. Central station design and specification. Light, power and signal systems for commercial and industrial buildings. Investigations, reports, design, layout, specifications, construction, inspection. Desires permanent position as electrical engineer with good opportunities for advancement. Connecticut or New York. B-1797.

ELECTRICAL ENGINEER, 31, married, no children, B. S. degree in 1923, working knowledge of Spanish. Over seven years' varied experience in planning, estimating, construction and operation of distribution and transmission systems. Location, immaterial. Available at once. C-9711.

ELECTRICAL ENGINEER, 32, married, Wisconsin graduate, construction, shop and seven years' power plant design experience. Available on short notice. C-9797.

EXECUTIVE ENGINEER, 40, graduate engineer, with ability to supervise and to create good-will and increase business through contacting and publicity. Would be valuable to electrical organization or organization serving the electrical industry. Has wide knowledge of industries and large acquaintance with engineers. C-9067.

ELECTRIC FURNACE PLANT MANAGER, mechanical engineer, abrasive and refractory experience. Engineering executive and designer. Expert in fluid flows and heat transfer problems. Analytical and inventive ability. Opportunity to secure experienced manager for small or branch plant. B-7972.

HYDROELECTRIC ENGINEER, 47, single. Degree Ph. B. in E. E., two years U. S. engineer. Ten years utility service as department manager, superintendent and chief engineer. Ten years Westinghouse industrial manager; five years electric dredging Alaska. Reports. Central America. Export manager Westinghouse two years. Available to go anywhere. B-6910.

ELECTRICAL ENGINEER, 44, married, B. S., E. E. Two years G. E. Test, eleven years motor applications; seven years with public utilities making variety of studies including transmission line, cable calculations, synchronous condenser applications, short circuit, load studies on d-c. calculating board, special research problems involving protective equipment. Location, United States. C-9811.

ENGINEERING DRAFTSMAN, 25, single, 2 years university training, 3 years' experience on power transmission lines, telephone work, and water resources. One year's experience as field aid. Available now. Will go anywhere. C-7118.

PLANNING ENGINEER, 31. Ten years' electrical-mechanical experience. Comprehensive knowledge coil, transformer, industrial meters and precision instrument design. Well versed in manufacturing methods, development, and cost reduction studies. Specialist in automatic control of processes, also general plant generation, transmission, distribution. Now employed. Accept position home or abroad. C-7258.

MECHANICAL-ELECTRICAL ENGINEER, 33, married. Graduate of recognized engineering school. Experienced in power generation. Five years teaching electrical and mechanical engineering. Heat power and specialty. High-voltage test. Extensive water gas research. Division engineer of water gas and coke ovens. Desires connection in teaching, public utility or industrial fields. Available immediately. C-9776.

ELECTRICAL ENGINEER, 33, married, B. S. in E. E. Ten years' experience as engineer with utility company. Familiar with design of lines and stations; accounting set-ups; executive duties and powers; modern business practise and now studying corporation law. Available at once. C-4734.

ELECTRICAL ENGINEER, 22, single, B. E. E. degree, 1931. Three years with Boston Edison Company, maintenance department on cooperative course. Temporarily employed last summer repairing Frigidaire cabinets for an ice cream company. Desires position offering some contact with engineering work. Location, anywhere. Available on two weeks' notice. C-9418.

GRADUATE ELECTRICAL ENGINEER, 27, single. Seven years' experience in supervising and laying out of electrical construction work in various industrial plants and buildings. Desires position as superintendent or electrical engineer with a contracting or industrial firm or municipality. Available at once. C-9553.

ELECTRICAL FOREMAN, 31, broad experience in power plant and factory construction, maintenance and operation. Exceptional ability in the erection and wiring of switchboards, power plant auxiliaries, oil circuit breakers and high-voltage substations. Available immediately. C-9783.

RECENT GRADUATE, age 21, single, citizen, good health, Protestant, B. E. E. degree, drafting and clerical experience, organization work. Would like to locate with a firm dealing with illumination of radio. Location, East. C-9756.

ELECTRICAL ENGINEERING GRADUATE, Columbia, 1931. Six-year man, single. Desires position with public utility or manufacturing concern. Studied especially power field, railroading and business administration. Experienced on automotive engines. Has acted as laboratory assistant in elementary E. E. courses. Languages: German and Spanish. Location, immaterial. Available immediately. C-9788.

RESEARCH PHYSICIST, 39, Ph. D., five years with Westinghouse on radio, television, sound recording and reproduction, four years bureau of standards and other government bureaus on optical design, heat engineering, also refrigeration experience, four years' teaching in prominent engineering schools, seeks responsible position in research or design. C-2588.

ELECTRICAL ENGINEER, 22, B. S.-E. E., 1930. Desires connection with public utility, electrical or radio manufacturing company. General Electric test experience. Six months' work with vacuum tubes. Experience with large motors. Location, immaterial. C-9806.

WIRING DIAGRAM SPECIALIST, 43, married, technical education, desires position with public utility. Understands cooperation necessary between office and field forces in connection with wirings. Familiar with power-house and substation layouts, conduit plans, bus structures, switchboards. Experienced in drafting and its application to field work. Location preferred East or South. C-8436.

ELECTRICAL ENGINEER, 36, single, E. E. degree. Desires position with public utility or engineering concern requiring executive ability and an analytical mind. Fourteen years' experience covering engineering, design and valuation of power plants, substations, transmission and distributions systems. Available immediately. Location, East. C-9570.

1931 GRADUATE of five-year cooperative school in electrical engineering. E. E. degree, age 23, single. Cooperative experience includes machine shop practise, telephone central office trouble shooting and experience with large municipal fire alarm system. Desires position with manufacturing concern or public utility. Willing to start at bottom. Location, Middle-west, preferred, but elsewhere satisfactory. C-9825.

ELECTRICAL ENGINEER, 29, single university graduate, Norwegian, now located in Canada. Five years' practical experience on drafting, designing, calculation, maintenance and testing for electrical machinery and equipment, substations, power transmissions, municipal and industrial distribution. Location, immaterial. Available on short notice. C-9822.

ELECTRICAL ENGINEER, 32, married, B. S. in E. E., graduate G. E. Test course, 3 years' practical experience light and power wiring, 3 years drafting, inspection, and installation of bank burglar alarm equipment. Desires position with electrical contracting company or bank burglar alarm company. B-8209.

TECHNICAL GRADUATE in mechanical and electrical engineering. Desires position as assistant sales engineer in electrical or mechanical equipment. Age 32, single, with ten years' experience in electrical and mechanical design and sales. Available at once. C-4510.

1931 GRADUATE ELECTRICAL ENGINEER, 29, 3 years' cooperative experience with large eastern public utility, single now, married when permanent position obtained. Desires position with utility, manufacturer or contractor. C-9834.

ELECTRICAL ENGINEER, 24, single, Iowa State College, 1931. Experience limited. Desires employment with public utility or manufacturing concern. Salary secondary to opportunity. Available at once. Location anywhere in the United States. C-9827.

ELECTRICAL ENGINEER, 30, married, B. S. in M. E. 1924, one year instructor of drawing and descriptive geometry in university. Six years design, construction of power plants, power substations, mining substations. Six months Westinghouse Test Course. Desires position as professor, instructor of design, electrical construction in university, technical school, Location, secondary. C-5734.

PRODUCTION OR EFFICIENCY ENGINEER, 26, E. E. graduate, 1929. Business administration. G. E. Test. Machine experience, turret lathes, boring mills, drills, millers, etc., automobile industry. Thoroughly familiar, tube rolling mill operations and processes. Distribution engineering, a-c. networks, electric utility. Private generating plants, studies and estimates on cost of retirement. Any location. C-9820.

GRADUATE ELECTRICAL ENGINEER, age 28, married, with years' experience in industrial plant construction and maintenance; railway electrification; power plant design, estimating, and construction. Supervisory experience on construction and costs with contractor. Desires position with utility, manufacturer or contractor, where ability to handle labor and produce results is a prerequisite. C-4428.

GRADUATE ELECTRICAL ENGINEER, University of Wisconsin, 32, single. Three years Westinghouse Test. Seven years supervising power plant, substation transmisson line construction. Eight years engineer inspector, purchasing, expediting, resident engineer, and writing specifications. Excellent reference. Desires connection with holding company, utility, contractor or manufacturer. Available immediately. Location, immaterial. B-9661.

ELECTRICAL ENGINEERING ASSISTANT, 26, married, college graduate, four years' transmission and distribution experience with public utilities on design, estimates, survey and evaluation. Desires connection with public utility engineering department. New York city location preferred, but will consider any United States location. C-5511.

GRADUATE ELECTRICAL ENGINEER, 1930, single. One year's experience on test, design and development of small fractional and integral horsepower motors. Previous experience with public utilities. Now employed. Position must be permanent and promise a good future. Location a secondary factor. C-9590.

DESIGNING ENGINEER, 33, American, technical education, married, experience with industrial, mining and public utility companies, on power plants, steam and Diesel installations, including all auxiliaries, air conditioning and ventilating systems, automatic railway substations, outdoor substations, ability to requisition equipment, knowledge of steel and concrete, can handle men. Location, immaterial. C-9849.

ELECTRICAL ENGINEER, 1930 graduate, 23, single. Fourteen months General Electric Test. Experience in automatic switchgear; circuit breakers; railroad motors, control, and locomotives; power rectifiers; synchronous converters, condensers, and motors; large motors, generators; transformers and variable speed a-c. machinery; calculating stability of transmission lines. Desires position in engineering field. Location, immaterial. C-9841.

ELECTRICAL ENGINEER, 22, single, B. S. E. E. 1931, from Pennsylvania State College, available on reasonable notice. One year's experience with silk-mill equipment, three months in transmission department of public utility, two semesters' motor tests in college. Desires position with utility, engineering or manufacturing company. Location, U. S., East preferred. C-9850.

MECHANICAL AND ELECTRICAL ENGINEER, research, development, reports, physical tests of materials, metallography, X-ray analysis. Languages: French and German. Available on short notice. Location immaterial. C-6994.

GRADUATE ELECTRICAL ENGINEER, 1929, 23, single; 15 months on G. E. Test Course. Desires position with utility or manufacturing company or with concern doing consulting or construction engineering. Available immediately. Location, New England preferred. C-8028.

ELECTRICAL ENGINEER, college graduate, age 23, married. Considerable experience in service and testing of fractional horsepower motors. Laboratory assistant and construction work while at college. Desires opening with advancement and opportunities. Available two weeks' notice. C-9084.

ENGINEER, 42, married; B. S. and E. E. Broad experience covering business, plant, sales management; executive engineering; research; drafting; patent investigations; organization and coordination of departments; assistant to busy executives; group engineering leadership; design and manufacture electrical and radio equipment. One employer sixteen years. Traveled extensively on business United States and abroad. C-9804.

INDUSTRIAL ELECTRICAL ENGINEERING GRADUATE, 1931, Pratt Institute, 23, single. Additional course taken in motor control. Four years' experience; power and lighting installation; servicing motors and control equipment. Some mechanical experience. Desires position with utility company; concern doing consulting or construction engineering or related work with manufacturing concern. C-9856.

DISTRIBUTION SUPERINTENDENT, 45, single. Graduate civil engineering. Two years transmission line surveying. Four years designing overhead lines, rural extensions, conversion from 2,300 to 4,000 volts. One year designing complete distribution systems in South America. One year superintendent operating company. Fluent Spanish, some French, German, Italian. C-2495.

ELECTRICAL ENGINEER, technical graduate, 31, married, desires position in electrical engineering field. Five years' experience in plant and substation construction, operation, maintenance and repairs; switchboard erection; motor and centrifugal pump installation and maintenance; inspection of electrical equipment. Location preferred, eastern United States. C-6273.

ELECTRICAL ENGINEER, graduate 1928, age 27, married. Has over two and one-half years' industrial testing experience, particularly in motor and control; also civil engineering and supervisory experience. Not afraid of responsibility. Desires a position with a future. Location immaterial. C-9568.

ELECTRICAL ENGINEER, age 32, married. Six years' experience with large manufacturer, on testing; design of a-c. machines, general and application engineering, and sales on power generation and transmission equipment. Three years' experience consulting and planning engineer for utilities. Desires connection with utility or manufacturer. Location immaterial. C-9814.

ELECTRICAL ENGINEER, 23, B. S. in E. E., University of New Hampshire, 1930. Fourteen months G. E. Test and general course. Test experience in transportation, motors and generators and vacuum tubes. Nine months summer work in main line electric railway shops. Interested in any engineering work. Available short notice. C-9859.

ELECTRICAL ENGINEER, technical graduate, American, age 29, married. Three years power test with G. E. and utility company. Three years research and development on electrical equipment. More interested in permanent connection with reliable concern than high starting salary. Eastern location preferred. Available immediately. C-1017.

GRADUATE ELECTRICAL ENGINEER, B. E. E. Degree 1930, age 24, single. Fourteen months' experience in the layout and estimation of underground network in a large city. Three months substation maintenance. Desires transmission line or distribution system work. Middlewest preferred. C-9860.

ELECTRICAL ENGINEER, 21, single; 1931 graduate with B. S. in E. E. Member of honorary fraternity in college and won scholarship three consecutive years. Summer experience with public utility. Interested in any electrical engineering field including vacuum tube work. Available at once. Location, New York preferred but not essential. C-9467.

PHYSICIST, 40, married; experienced in X-ray, radium and high frequency, desires position in electrical research. C-8604.

ELECTRICAL ENGINEER, graduate, 1929, cooperative school, American, Protestant, 31, married. Three years design, engineering, appraisal. Six years electrical construction, generating station and substation power company. Wishes position with public utility as junior engineer or in research laboratory. Will go anywhere, United States. Available now. Unemployed. C-9861.

GRADUATE ENGINEER, Stevens Institute of Technology, 1931, single, 22, available immediately. Desires position in any electrical line with opportunity for advancement. Location, immaterial. C-9473.

MECHANICAL AND ELECTRICAL ENGINEER, married; degrees here, and Doctor, Germany for research. Fifteen years connected and in charge purchasing, sales and export office handling materials every possible description in large amounts. Wide business experience. Linguist. Adaptable to any position outside those mentioned. C-7823.

ELECTRICAL ENGINEER, 26, single, 1928 graduate of recognized university with B. E. E. degree; four years' engineering experience; including 20 months on large electrified railroad, one year public utility test experience, one year communication and radio experience. Desires engineering position. Free to locate anywhere. C-9112.

GRADUATE ELECTRICAL ENGINEER, M. S. in E. E., 1931 from Massachusetts Institute of Technology majoring in communications.

ENGINEERING SOCIETIES EMPLOYMENT SERVICE

57 Post St. San Francisco N. D. Cook, Manager	205 West Wacker Drive Chicago L. E. Griffith, Manager	31 West 39th St. New York W. V. Brown, Manager

MAINTAINED by the national societies of civil, mining, mechanical, and electrical engineers, in cooperation with the Western Society of Engineers, Chicago, and the Engineers' Club of San Francisco. An inquiry addressed to any of the three offices will bring full information concerning the services of this bureau.

Men Available.—Brief announcements will be published without charge; repeated only upon specific request and after one month's interval. Names and records remain on file for three months; renewable upon request. Send announcements direct to Employment Service, 31 West 39th Street, New York, N. Y., to arrive not later than the fifteenth of the month.

Opportunities.—A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

Voluntary Contributions.—Members benefiting through this service are invited to assist in its furtherance by personal contributions made within 30 days after placement on the basis of 1.5 per cent of the first year's salary.

Answers to Announcements.—Address the key number indicated in each case and mail to the New York office, with an extra two-cent stamp enclosed for forwarding.

Desires position with electrical company or as instructor in electrical engineering, physics or mathematics. Summer experience with telephone company. Available immediately. Location immaterial. Age 23. C-9674.

1931 TECHNICAL GRADUATE, B. Sc. in E. E. from a midwestern University, desires permanent connection with chance for advancement. Age 26. Location immaterial. Available immediately. C-9717.

ELECTRICAL ENGINEER, 1930, single, 22, graduate Pratt Institute. Desires position in any electrical line with opportunity for advancement. Has had electrical and mechanical engineering and drafting experience. Location immaterial. Available immediately. C-8380.

ELECTRICAL ENGINEER, 1924 graduate, B. S. E. E., 29, married. Seven years' experience testing, inspecting, installing various electrical equipment. Writing reports. Assistant to manager power and light utility. Purchasing electrical supplies. Available immediately. Detailed information, references gladly furnished. Welcomes opportunity particularly in operating, maintenance department, public utility or manufacturing concern. C-4981.

SALES EXECUTIVE. Not afraid to work, not too old to acquire new ideas. Electrical training, Worcester Polytechnic Institute. Seven years directing engineering sales and sales through distributors. Capable of contacting industrial or electrical field with either an electrical or mechanical product. Industrious, with dependent, ready to go to work. C-5431.

ELECTRICAL ENGINEER, 1928 graduate. Three years' experience in large industrial plant on maintenance and operation of all kinds of motors, switchboards, electric heating, pyrometers, regulators and transformers, both theoretical and practical. Desires any electrical position. C-9845.

TECHNICAL GRADUATE, 38, married; desires position in engineering or operating department of power company. Has had 11½ years' experience with distribution engineer and operating and construction departments of public utility; 1½ years test; and 3 years shop experience. Location immaterial. B-9248.

ELECTRICAL DESIGN ENGINEER, 25 years' experience with public utilities, industrial companies, steam, hydroelectric power plants, H. T. indoor and outdoor substations, copper and nitrate mining plants, layouts, specifications, purchase of equipment, able to take charge, seeks position of responsibility. New York State professional engineer's license. B-7031.

1931 GRADUATE, North Carolina State College, B. S. in E. E., 25. Would take position of any type that offers advancement. Member of Tau Beta Pi and Phi Kappa Phi. Willing to go anywhere. C-9865.

Membership

Applications for Election

Applications have been received by the secretary from the following candidates for election to membership in the Institute. Unless otherwise indicated, the applicant has applied for admission as an Associate. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the Secretary before October 31, 1931.

Bennett, D. S., Worcester Electric Light Co., Worcester, Mass.

Bibish, J. E., Libbey Owens Ford Glass Co., Toledo, Ohio

Burch, W., Carolina Power & Light Co., Raleigh, N. C.

Craton, F. H., General Electric Co., Erie, Pa.

Davies, L. S., Provincial Mental Hospital, Essondale, B. C., Canada

Dubielzig, R. C., 3361 N. 24th St., Milwaukee, Wis.

Ellis, C. R. (Member) Electric Bond & Share Co., New York, N. Y.

Goodenough, F. J., Amalgamated Electric Corp., Toronto, Canada

Gove, H. E., Union Electric Light & Power Co., St. Louis, Mo.

Harrington, N. F., R. W. Cramer & Co., New York, N. Y.

Hart, J. W., Electric Bond & Share Co., New York, N. Y.

Hogan, J. P. (Member) Parsons, Klapp, Brinckerhoff & Douglas, Enggs. & Managers, New York City, N. Y.

Ianantuono, Michael, 156 Sullivan St., New York, N. Y.

Jordan, R. L., University of Illinois, Urbana, Ill.

Karlsson, E. E., Associated Telephone Co., Ltd., Los Angeles, Calif.

Keller, E. A., Crocker-Wheeler Co., Ampere, N. J.

Kron, J., 144-30 35th Ave., Flushing, N. Y.

Laiho, J. M., 34 Remsen St., Brooklyn, N. Y.

Laughlin, C. W., American Tel. & Tel. Co., Kansas City, Mo.

Lober, C., Kansas City Power & Light Co., Kansas City, Mo.

Murphy, L. J., Westinghouse Elec. & Mfg. Co., New York, N. Y.

Nicolaisen, J. Z., Beauharnois Construction Co., Beauharnois, Que., Can.

Novotny, F. J., International Tel. & Tel. Co., New York, N. Y.

O'Beirne, F. H. C., Canadian Utilities, Ltd., Yorkton, Sask., Can.

Saxe, J., Electric Co. of Costa Rica, Cartago, Costa Rica, Central America

Speckmann, F. William, Jr., 312 Grove St., Newark, N. J.

Tamburello, G., 307 West 20th St., New York, N. Y.

Van Brunt, G. A. (Member) McGraw-Hill Publishing Co., New York, N. Y.

Voras, F. J., New York & Queens Elec. Lt. & Pr. Co., Flushing, N. Y.

Wilson, I. H., General Electric Co., West Lynn, Mass.

Woodford, L. G. (Member) American Tel. & Tel. Co., New York, N. Y.

31 Domestic

Foreign

Dutta, S. K., Berlin Electric Supply Corp., Berlin, Germany

Ellis, D. W. V. (Member) Government of Northern Rhodesia, Ndola, No. Rhodesia, So. Africa

Kanga, D. P., College of Technology, Manchester, Eng.

Ratnam, V. S., Delhi Cloth Mills, Delhi, India

4 Foreign

October 1931

Order Form for Pamphlet Copies of A. I. E. E. Papers*

Papers presented prior to September 1931 and upon which articles in this issue are based

Number	Author	Title
☐ 31-14	G. M. Schrum and H. G. Weist, Jr	Some Experiments with Arcs Between Metal Electrodes
☐ 31-29	W. J. McClain	Electrical Distribution Systems for Industrial Plants
☐ 31-43	M. A. Hyde, Jr	Synchronous Motor with Phase-Connected Damper Winding for High-Torque Loads
☐ 31-49	A. W. Hull and H. D. Brown	Mercury-Arc Rectifier Research
☐ 30-50	W. R. King	Electron Tubes in Industry
☐ 31-52	D. W. McLenegan and A. G. Ferriss	Synchronous Motors—Design and Application to Meet Special Requirements
☐ 31-70	E. V. DeBlieux	Losses in Transformers for Use with Mercury Arc Rectifiers
☐ 31-98	P. B. Juhnke	Communication Facilities of a Metropolitan Power System
☐ 31-104	R. N. Conwell, G. M. Keenan, C. F. Craig, and E. C. Briggs	Communication Serivces of Electric Utilities—Underlying Considerations
☐ 31-111	E. S. Bundy	Communication in the Western Division of the Niagara Hudson System
☐ 31-113	C. A. Booker and M. E. Clark	Cooperative Study of Power System Communication
☐ 31-116	E. C. Stewart	Communication on the Arkansas-Louisiana-Mississippi Interconnected System
☐ 31-132	J. Slepian and L. R. Ludwig	Backfires in Mercury Arc Rectifiers
☐ 31M8	P. N. Winther	Electric Arc Welding in Building Construction
☐ 31M13	C. H. Frier	Telegraphic Pilot-Wire Relay System

*Members, Enrolled Students, and subscribers are entitled to one pamphlet copy of any paper in this list if requested within one year from above date. Thereafter a charge of twenty-five cents per copy will obtain.

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New Books

In the Societies Library

AMONG the new books received at the Engineering Societies Library, New York, during August are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface or text of the book in question.

BERECHNUNG VON DREHSTROM-KRAFTUBERTRAGUNGEN. By O. Burger. 2nd ed. Berlin, J. Springer, 1931. 183 pp., illus., diagrs., charts, tables, 8 x 6 in., cloth. 13.50 r. m.——A concise yet complete description of a practical method for the calculation of the electrical characteristics of three-phase transmission systems of any capacity. The method given is the outgrowth of many years of experience with the Siemens-Schuckert Works.

DIE BETRIEBSUNTERSUCHUNG WEGE UND FORMEN. By O. Bredt. Berlin, VDI Verlag, 1931. 56 pp., charts, tables, 12 x 8 in., paper, 12 r. m.——Dr. Bredt discusses the development of management-research in America and Europe and presents a detailed description of the methods used in five typical cases. These cases are then criticized in detail, and the efficacy of the methods used is discussed. The general principles and methods of procedure are then demonstrated by reference to an investigation by the National Board of Economics of Germany. The book shows the possibilities of management research and is a brief compendium of methods.

DIELECTRIC CONSTANT AND MOLECULAR STRUCTURE. American Chemical Society Monograph 55. By C. P. Smyth. N. Y., Chemical Catalog Co., 1931. 214 pp., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.——The author has correlated and organized the known facts bearing upon the problems of electric moment, molecular structure and intermolecular action, and uses them in a critical examination of the theories and hypotheses in terms of which they are interpreted.

DRUCKWECHSEL UND STOSSE AN KOBLENMASCHINEN MIT SCHUBKURBELGETRIEBE. 1 v. Text and 1 v. Tables. By F. Kuba. Vienna, Julius Springer, 1931. 69 pp., diagrs., tables, 14 x 9 in., paper, 18 r. m.——A theoretical investigation of the phenomena accompanying reversals of pressure in reciprocating engines. The author develops a method of determining the relative velocity of the various phenomena, analyzes these phenomena into special components and points out the effect of changes in the conditions upon the relative magnitudes. The investigation aims to afford a sound basis for studying shocks in engine bearings, etc. A critical review of previous publications on the subject is included.

ECONOMICS FOR ENGINEERS. By E. L. Bowers and R. H. Rowntree. N. Y., McGraw-Hill Book Co., 1931. 490 pp., diagrs., charts, maps, tables, 9 x 6 in., cloth. $4.00.——This text-book on economics has been written to give engineering students a knowledge of economic principles and problems. The subject is presented very concisely, in order not to burden the curriculum unduly, and the engineering aspects of economic theory and business activity are emphasized. A practical presentation of the subject from an engineering point of view.

ENGINEERING PROBLEMS MANUAL. By F. C. Dana and E. H. Willmarth. 2nd edit. N. Y., McGraw-Hill Book Co., 1931. 252 pp., illus., diagrs., charts, tables, 8 x 5 in., $2.00.——This manual has been prepared primarily for use in the courses in engineering problems now given at some colleges to train the beginner in proper habits, effective methods and systematic workmanship, and to correlate his courses in physics and mathematics with engineering. It contains specifications for computation sheets, advice on habits of work and study, concise notes on fundamental principles and mathematics, three hundred practical problems and a collection of tables. The new edition has been revised and partly rewritten.

LE FACTEUR DE PUISSANCE, DES INSTALLATIONS ELECTRIQUES INDUSTRIELLES. By R. Menjelou. Paris, Dunod, 1931. 239 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, 73 frs.——A systematic review of the power-factor problem. The effect of the power factor upon electric systems, the causes of a poor power factor and the methods by which it can be improved are discussed.

DAS FERNSPRECHWESEN III. SAMMLUNG GOSCHEN BD. 1043. By H. Schmidt. Berlin and Leipzig. Walter de Gruyter & Co., 1931. 139 pp., illus., diagrs., charts, 6 x 4 in., cloth, 1,80 r. m.——A brief elementary description of the principles of automatic telephony, describing the design and operation of the various types of apparatus in use.

FORSCHUNGSHEFT 346. WARMSPANNUNGEN IN GLEICHDRUCKWARMESPEICHERN. By E. Mayer. Berlin, VDI-Verlag, 1931. 23 pp., diagrs., charts, 12 x 9 in., paper, 5 r. m.——This research report deals with an experimental and theoretical investigation of the heat stresses in steam accumulators of the constant pressure type. The work was done at the Karlsruhe Technical University.

INHALTSVERZEICHNIS DER ZEITSCHRIFT DES VEREINES DEUTSCHER INGENIEURE, 1926-1930. Bd. 70-74, Berlin, VDI Verlag, 1931. 138 pp., 12 x 8 in., paper, 8 r. m.——This index, covering the last five volumes of the "Zeitschrift," contains over 3,500 entries to authors and subjects, and is an important guide to recent engineering developments, especially to the work of German engineers.

INTERNATIONAL CRITICAL TABLES OF NUMERICAL DATA, PHYSICS, CHEMISTRY AND TECHNOLOGY, INDEX v.1-7. By the National Research Council. N. Y., McGraw-Hill Book Co. 1930. 43 pp., 11 x 9 in., paper.——An index to the complete set, published in four languages, English, French, German and Italian.

MATERIALS OF CONSTRUCTION. By A. P. Mills. 4th ed., edited by H. W. Hayward. N. Y., John Wiley & Sons, 1931. 423 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.——The aim of this work is to supply a general text-book upon the manufacture, properties and uses of the common engineering materials, for students of engineering. The book is to be supplemented by a laboratory course in the testing of materials. The new edition has been revised and enlarged.

POWER AND THE INTERNAL COMBUSTION ENGINE. By W. E. Dalby. N. Y., Longmans, Green & Co., 1931. 280 pp., diagrs., charts, tables, 9 x 6 in., cloth, $7.00.——Professor Dalby here treats of the common principles of the internal combustion engine. The first chapter is devoted to the physical and thermodynamical properties of a working agent formed from a gaseous charge by explosion. The second chapter considers in more detail fuels and the charges formed by mixing them with air, and the products of their combustion. The engine and its performance are the subject of chapter four, which is followed by a chapter on the performance diagram devised by the author. Succeeding chapters are devoted to the suction gas plant, the gasoline engine, and the effect of heat flow on design. The book contains much to interest the designer.

PRINCIPLES AND PRACTICE OF GEOPHYSICAL PROSPECTING, report of the Imperial Geophysical Experimental Survey. Cambridge (England) University Press; N. Y., Macmillan Co., 1931. 372 pp., illus., diagrs., charts, maps, tables, 11 x 9 in., cloth, $5.00.——This report records the results of eighteen months of work in Australia, undertaken to test the applicability of the principal geophysical methods under field conditions, for the purpose of determining their practical value and relative merits. Electrical, gravimetric, magnetic and seismic methods were used in country carrying sulphide and other ores, graphite, brown coal, saline waters, etc. The report is more in the nature of a manual of geophysical prospecting, illustrated by field results, than of a formal report. In part one the field investigations and elementary expositions of the different methods are given in readily understood form. Part two explains the field procedure in greater detail and discusses the design of apparatus, the interpretation of results and the underlying theory. Much new information upon electrical instruments is included.

SCIENCE AND RELIGION, a Symposium with a foreword by M. Pupin. N. Y., Charles Scribner's Sons, 1931. 175 pp., 8 x 5 in., cloth, $1.75.——In the fall of 1930 the British Broadcasting Corporation arranged a series of talks, in which eminent scientists, churchmen, and philosophers were asked to give their personal interpretation of the relation of science to religion and to determine to what degree the conclusions of modern science affect religious dogma and the fundamental tenets of Christian belief. These addresses now appear in print, with a oreword by Professor Pupin, and are, of unusual interest as a representation of the mature thought of distinguished leaders in the two fields. Among the twelve contributors are Sir J. Arthur Thomson, Julian Huxley, Sir Arthur Eddington, the Bishop of Birmingham, Dean Inge and Canon Streeter.

TELEVISION. By E. H. Felix. N. Y., McGraw-Hill Book Co., 1931. 272 pp., illus., diagrs., charts, 8 x 5 in., cloth, $2.50.——This book explains the basic processes involved in any television system and describes the methods of existing systems. The standards of performance requisite to commercial service are outlined, and the limitations of existing methods are pointed out. The book gives a good general survey, in not too technical language, of the present situation, the problems that television faces, and its probable future.

VECTOR REPRESENTATION FOR ELECTRICAL METERMEN. By D. T. Canfield. N. Y., McGraw-Hill Book Co., 1931. 180 pp., diagrs., charts, tables, 8 x 6 in., cloth, $2.00.——This book explains the vector representation of alternating voltages and currents in simple language, with very little use of mathematics. The theory of vectors and their manipulation are first described in a non-mathematical, non-technical way. This is followed by a more technical presentation of the subject, after which the use of vectors in the solution of polyphase problems and power-factor correction is shown by practical examples. While intended primarily for metermen, the book will be useful to any one seeking an elementary text.

2ND WORLD POWER CONFERENCE, Berlin, 1930. Transactions, Bd. 20, Index. Berlin, VDI-Verlag, 10 x 6 in., cloth, $85.00 per set.——This volume completes the Transactions of this conference, held in Berlin in June, 1930. The Transactions contain the papers presented, numbering over three hundred and fifty. These are in twenty volumes of handy size, each containing papers upon related subjects, which may be purchased singly. These are fully indexed by author and subject in this final volume. The index is tri-lingual—English, German, and French.

FRENCH-ENGLISH AND ENGLISH-FRENCH DICTIONARY OF COMMERCIAL AND FINANCIAL TERMS, PHRASES AND PRACTICE. By J. O. Kettridge. N. Y., E. P. Dutton & Co., 1931. 647 pp., 10 x 7 in., cloth, $7.50.——This work gives the translations of fifty thousand words, terms and phrases frequently used in commercial and financial writings, and illustrates their use by numerous examples and explanations. The book is clearly printed and of convenient size. It will fill a long felt want among translators, as it occupies a new field, and will do so very satisfactorily.

CREEP OF METALS. By H. J. Tapsell. London, Oxford University Press, 1931. 285 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, 30 s. (American Price $12.00).——A very complete presentation of the data available upon the creep of metals at high temperatures. The work of the various investigators has been correlated, in the light of the test methods used by them, with the aim of enabling the engineer to a satisfactory interpretation of present and future data, and the successful use of them.

Selected Items From Engineering Index Service

SELECTED references to current electrical engineering articles from Engineering Index Service's review of some 2,000 technical periodicals are given in the following columns.

All articles indexed are on file in the Engineering Societies Library, New York, which will furnish photoprints of any article at a cost of 25 cents per page or make translations of foreign articles at cost.

Armatures

WINDINGS. Unbalanced Voltage in Armature Coils, R. M. Baker. *Elec. Jl.*, vol. 28, no. 5, May 1931, pp. 315-317, and 321, 12 figs. Set-up for studying circulating current conditions by means of oscillograph analysis of results.

Busbars

Current-carrying Capacity of Bare Clyindrical Conductors for Indoor and Outdoor Service, C. W. Frick. *Gen. Elec. Rev.*, vol. 34, no. 8, Aug. 1931, pp. 464-471, 8 figs. Carrying capacity tables for bare indoor conductors and at 100 per cent conductivity copper, horizontal position, 40 deg. cent. air temperature in large rooms without drafts and 60 cycles and for bare outdoor conductors of same material in partly sheltered locations; relative capacities for conductors of same diameter and cross-section made of metals having different values of conductivity; formulas for calculation of current *vs.* temperature rise; resistance data.

TESTING. Aluminum Busbars Resist Power Arcs, J. D. Porter. *Elec. World*, vol. 98, no. 3, July 18, 1931, pp. 104-105, 1 fig. Tests made by engineers of Westinghouse Electric & Manufacturing Co.'s high-power laboratory on behalf of Aluminum Co. of America, in order to determine effect of power arcs of long duration on tubular aluminum busbar under various currents and with several different weights and thicknesses of tubing.

Cables

DIELECTRIC LOSSES. The Significance of Dielectric Loss in High Voltage Cables, M. C. Timms. *Elec. Engr. Australia and New Zealand*, vol. 8, no. 3, June 15, 1931, pp. 95-100, 5 figs. Origin of dielectric loss; leakance; ionization loss; analysis of dielectric loss; effect of inherent dielectric loss; variation of power factor; effect of ionization loss.

Dielectric Loss-Angle Measurement of Multi-Core High-Tension Cables, With Special Reference to the Schering Bridge, L. G. Brazier. *Instn. Elec. Engrs.—Jl.*, vol. 69, no. 414, June 1931, pp. 757-770, 14 figs. Special difficulties of dielectric loss angle; measurement on multi-core cables are examined; conclusion is reached that inter-admittance cannot be considered to have associated with it definite dielectric loss-angle; new method of obtaining inter-dielectric loss-angle in conformity with conclusions of section; wavelength effect appreciably affects apparent dielectric loss-angle when cable exceeds in length small fraction of wavelength.

Cables, Telephone

FAULT LOCATION. Bridge Methods for Locating Resistance Faults on Cable Wires, T. C. Henneberger and P. G. Edwards. *Bell System Tech. Jl.*, vol. 10, no. 3, July 1931, pp. 383-407, 18 figs. Bridge methods for locating resistance faults on cable wires, with special reference to theory of methods for locating insulation faults which cause complete cable failure, locating insulation faults of high resistance, and locating series resistance unbalances.

NOISE ELIMINATION. Telephone Cable Circuit Noise and Power Distribution Systems. *Nat. Elec. Light Assn.—Pub.*, no. 147, July 1931, 4 pp., 5 figs. Results of study made to determine factors involved in power distribution systems and telephone exchange plants which contribute to noise problem; relative influence of various types of power distribution systems and relative susceptiveness of various types of telephone exchange cable circuits are shown.

Circuit Breakers

How Deion and Deion-Grid Circuit Breakers Operate, H. N. Blackmon. *Power*, vol. 74, no. 5, Aug. 4, 1931, pp. 161-163, 8 figs. Two high-voltage circuit breakers, Deion, which is air-break type and Deion-grid, oil-break type, have come into use recently; although both remove ions from arc when interrupting circuit, they operate on entirely different principles.

Clocks, Electric

MOTORS. Measuring 0.000011 Horsepower, T. R. Watts. *Elec. Jl.*, vol. 28, no. 7, July 1931, p. 418, 3 figs. Special spring dynamometer was recently constructed for running speed-torque tests on 200 r. p. m. clock motors of approximately 11 millionths of hp.

Diesel Electric Plants

AUTOMATIC. Automatic Diesel-Electric Plant, E. J. Kates. *Machy. Market*, no. 1604, July 31, 1931, pp. 19-20. Paper before Am. Soc. Mech. Engrs., previously indexed from Advance Paper, for mtg. June 23-26.

Dust Precipitation

ELECTRIC. Harvard Medical Power Extension Precipitates Dust Electrically, G. K. Sauerwein. *Power*, vol. 74, no. 7, Aug. 18, 1931, pp. 226-229, 6 figs. Variety of services applied by Harvard Medical School power plant, which employs electrostatic precipitation of flue dust; design and operating characteristics of boiler plant equipment.

Education

Education for the Engineering Industry, Lond., H. M. Stationery Office, 1931, 67 pp., 1s. 3d. Report of Committee on Education for Engineering Industry and comments on report by educational bodies; factors in recruitment to industry; recruitment from different types of school and from Universities; training in works; promotion in relation to training and instruction; organization of part-time education; subjects of instruction in technical schools and colleges; trade courses; foundry work; instruction in crafts; conclusion.

Electric Drive

Individual or Group, D. C. McGuire. *Elec. Jl.*, vol. 28, no. 8, Aug. 1931, pp. 456-459, 2 figs. For average installation, when all factors have been considered, first cost for individual motor drive and for group drive is approximately same; power and labor costs are more important than first cost; overall efficiency of drive should be accurately determined because cost of power is largest single item entering into cost of operation; various tables showing installation operation costs are given.

New Multi-Speed Drive. *Elec. Jl.*, vol. 28, no. 8, Aug. 1931, p. 490, 2 figs. Movement of handle selects any one of four speeds for driven equipment, constant-speed motor running under full load; drive has motors and gears made in single unit, and is designed for constant horsepower output.

CALENDARS. Synchronizing Operation of Calendar Trains, R. G. Lockett. *Chem. and Met. Eng.*, vol. 38, no. 7. July 1931, pp. 407-409, 3 figs. Control problem centers around necessity of handling group of motors in unison at various speeds and at times arranging for adjustable "draw" between units; rubber-tire fabric calendars ordinarily are driven by two to one d-c. motors operating on two-voltage system, while some forms of textile-printing machines operate on variable-voltage d-c. system providing much greater speed variation.

STEAM POWER PLANTS. Large and Small Motors in the Modern Industrial Steam Power Plant, E. A. Murray. *Eng. and Finance*, vol. 25, no. 1, July 1931, pp. 7-8. General types of electric motors for essential and non-essential auxiliaries in power plant; mechanical construction and control.

Electric Equipment

COAL MINES. Automatic Portable Conversion Equipment at the Wildwood Mine of the Butler Consolidated Coal Co., A. L. Lee. *Gen. Elec. Rev.*, vol. 34, no. 8, Aug. 1931, pp. 459-463, 6 figs. Portable starting and running equipment for portable motor-generator set of 300 kw., 2,300 volts a-c., 275 volts d-c., 1,200 r. p. m.; details of substation.

Electrolytes

The Rapid Determination of Current Efficiency in the Electrolysis of a Zinc Sulfate Electrolyte. *Electrochem. Soc.—Preprint*, no. 60-1, for mtg. Sept. 2-5, 1931, 7 pp., 2 figs. Roasted blende is leached with spent acid sulphate from cell room; before discharging zinc-enriched solution back into cells, it is advisable to test it as to cathode efficiency, which is sensitive indicator of quality of solution; new apparatus and comparatively described have been in satisfactory use for several months.

Engineers

RUSSIA. American Engineers in Russia, J. M. Carmody. *Eng. News-Rec.*, vol. 107, no. 7, Aug. 13, 1931, pp. 262-264. Comments upon engineering status, living conditions, technical problems and future prospects; employment contracts; engineers must be teachers.

Frequency Meters

VACUUM TUBE. A Thermionic Type Frequency Meter For Use Up to 15 KC, F. T. McNamara. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 8, Aug. 1931, pp. 1384-1390, 7 figs. New type of frequency meter which is adapted to measurement of low and intermediate frequencies; instrument absorbs negligible amount of power from circuit being tested, has linear calibration curve and sensitivity of about eight microamperes for one per cent change in frequency; experimental model is described in detail; input is between five and ten volts; other models may require different inputs.

FURNACES. Welding Stresses are Relieved in the Electric Furnace, C. C. Brinton. *Elec. Jl.*, vol. 28, no. 8, Aug. 1931, pp. 478-479, 5 figs. Car-type furnace for use in reducing welding stresses; floor and front wall are mounted on truck that moves in and out of furnace proper; three heater banks are connected star-delta from 60-cycle, 2,300-volt supply source through three 2,300-230/115-volt transformers, with circuits so arranged that each bank may be operated independently; furnace rating is 375 kw., 60 cycle, three phase.

COOLING. Electrical Furnaces with Artificial Atmospheres. *Nat. Elec. Light Assn.—Pub.*, no. 141, July 1931, 9 pp., 16 figs. Value of artificial atmospheres, processes and furnaces which lend themselves to use of artificial atmospheres; gases used and their source of supply; possible future applications; specific uses of artificial atmospheres and functions of gases; illustrations showing furnaces, objects and charges treated, and gas generating equipments.

Fuses

Fuse Performance in Circuit-Interrupting Service, H. D. Braley. *Power*, vol. 74, no. 4, July 28, 1931, pp. 130-133, 11 figs. Fuse considered in its ability to interrupt circuit, and factors that influence its performance in that duty; results of series of overload tests made on different size fuses.

Generators

CONTROL. Automatic Direct-Current Load Shifting Control, L. D. Whitelock. *Elec. Jl.*, vol. 28, no. 5, May 1931, pp. 289-290, 2 figs. Load-shifting apparatus controls d-c. generator voltage instead of placing resistors in bus system; its cost is so reasonable that it is now feasible to install automatic load-shifting equipment in stations which would otherwise be manually operated.

Hydroelectric

POWER DEVELOPMENTS. Hydroelectric Development of the Mokelumne Basin, E. A. Crellin. *Elec. West*, vol. 67, no. 2, Aug. 1, 1931, pp. 54-62, 18 figs. Highest of its kind, Salt Springs rockfill dam halts Mokelumne River, impounding water to produce now 71,000 kva., eventually to supply white coal to four plants with 176,000 kva. installed capacity; descriptions of Salt Springs power house, Tiger Creek conduit, and Tiger Creek power house; wiring diagrams are given.

POWER PLANTS. Saluda Development is Rich in New Engineering Features, A. P. Campbell, J. P. Garvin, A. W. Reed, and N. D. Urquhart. *Elec. Jl.*, vol. 28, no. 5, May 1931, pp. 265-268, 7 figs. Plant has added additional 130,000 kw. to generating capacity in South Carolina, besides having created second largest artificial lake in United States, and largest earth filled power dam in world; built for Lexington Waterpower Co. on Saluda River near Columbia, S. C., it will have ultimate capacity of 195,000 kw., at present four 32,500 kw. generators are installed.

Maintaining Equipment in Hydroelectric Plants, J. E. Housley. *Power*, vol. 74, no. 7. Aug. 18, 1931, pp. 239-241, 4 figs. Inspection and maintenance methods that have proved successful and are outgrowth of eleven years' experience on system that has increased in size to where there is now nearly 300,000 hp. installed capacity.

REMOTE CONTROL. Remote-Controlled Hydro Station. *Elec. World*, vol. 98, no. 4, July 25, 1931, p. 154, 1 fig. Remote automatic controls for hydro stations are used very frequently; diagram showing essential features of remote-control system developed and applied by General Control Corp.; operation.

WATER STORAGE. Chart Simplifies Water-Flow Problems, R. Ball. *Power*, vol. 74, no. 6, Aug. 11, 1931, pp. 202-203, 2 figs. By use of storage-reservoir-capacity curve and second-foot scale, problems on available water for power generation are easily worked out.

Lamps

ULTRAVIOLET. A New Source of Ultraviolet Radiation, J. W. Marden and M. G. Nicholson. *Illum. Eng. Soc.—Trans.*, vol. 26, no. 6, July 1931, pp. 592-601 and (discussion) 601-610, 8 figs. partly on supp. plate. Type of mercury vapor ultraviolet lamp, with possibilities; discussion on mechanical construction, electrical characteristics, and development problems encountered; curves, oscillograms and drawings are included; problem of measuring ultraviolet output; brief treatment of ballast devices to be used with lamp is given, and method of adapting these and glow lamp on 115-volt circuit is considered.

Lighting

Physical Characteristics of Sunshine and Its Substitutes, C. E. Greider and A. C. Downes. *Illum. Eng. Soc.—Trans.*, vol. 26, no. 6, July 1931, pp. 561-571, 6 figs. partly on supp. plates. Measurements made of energy distribution of solar radiation throughout spectrum and of its variation with altitude, location and time of year; attempt has been made to correlate these physical data with clinical experience as to best kind of sunlight for health maintenance; biological significance of various portions of sun's spectrum is discussed; comparison between natural sunlight and one type of artificial sunlight. Bibliography.

The Biologically Active Component of Ultraviolet in Sunlight and Daylight, W. W. Coblentz. *Illum. Eng. Soc.—Trans.*, vol. 26, no. 6, July 1931, pp. 572-577. Attention is called to atmospheric pollution by products of combustion of automobiles and oil-burning heaters, which greatly reduce intensity of ultraviolet vitalizing rays of sunlight; biological data are cited showing that, while healing of rickets is possible in strong light from sky, for effective therapeutic results, obtainable by exposure for convenient interval of time, direct exposure to sunlight is essential. Bibliography.

VISION RELATIONSHIP. Seeing, a Partnership of Lighting and Vision, M. Luckiesh and F. K. Moss. Baltimore, Williams and Wilkins Co., 1931, 241 pp., illus., diagrs., charts, $5.00. Seeing depends upon light and lighting, as well as upon eyes and visual sense; yet light and lighting have not yet received much consideration as partner of visual sense, although excellent scientific data pertaining to vision are available: present book aims to remedy this lack, in part, by giving results of extensive research work, covering some twenty years and undertaken to establish scientific principles of seeing. Bibliography. Eng. Soc. Lib., N. Y.

AIRWAY. Requirements for Airdrome and Air-Route Lighting at Present Time, C. E. Ward and W. M. Hampton. *Cinquieme Congres International de la Navigation Aêrienne (5th International Congress of Avigation)*, vol. 1, Sept. 1-6, 1930, pp. 192-199. Requirements from viewpoint of pilots and navigators; limits imposed on lighting installation by costs, standardization of apparatus to simplify manufacture, installation and maintenance; responsibility for installation as it concerns governments, municipalities and aircraft operating companies; difference between needs of commercial aircraft operators and private owners of aircraft or amateur pilots. (In English.)

MEASUREMENT. The Photoelectric Measurement and Photographic Recording of Daylight, W. A. Thomson. *Can. Jl. Research*, vol. 4, no. 6, June 1931, pp. 559-564, 7 figs. Method is described by which illumination intensities were measured by photoelectric cell and galvanometer, and continuous photographic record obtained of variations of intensity over period of time during which ground was covered with snow: it was found that remarkable increase in illumination was caused by presence of cloudiness with full sunshine.

ULTRAVIOLET. The Mercury Arc in Hygienic Illumination, L. J. Buttolph. *Illum. Eng. Soc.—Trans.*, vol. 26, no. 6, July 1931, pp. 578-591, and (discussion) 601-610, 14 figs. To meet general conviction that there must be perceptible erythema as evidence of beneficial effect from ultraviolet in hygienic industrial illumination, Cooper Hewitt lamp will be constructed of glass having increased ultraviolet transmission; value of new lamp is predicted graphically from its relative energy distribution, and erythematic effect curves.

Lines

CALCULATION. Line Loss Calculations, S. W. Marshall, Jr. *Gen. Elec. Rev.*, vol. 34, no. 8, Aug. 1931, pp. 472-473, 1 fig. Theoretical, mathematical analysis; calculations are based on assumption of constant value of charging current per mile for transmission line, constant value of transformer exciting current and constant iron loss for load terminal transformers.

DESIGN. Sags and Tensions in Overhead Lines, C. G. Watson. London and New York, Isaac Pitman and Sons, 1931, 192 pp., diagrs., charts, tables, $3.75. Simple methods of determining sags and tensions which are accurate, yet require no further mathematical knowledge than ability to plot and read graphs, and perform simple arithmetical operations; tables and graphs of hyperbolic and catenarian functions of tangents, etc. Eng. Soc. Lib., N. Y.

LIGHTNING PROTECTION. Direct Strokes to Transmission Lines, W. W. Lewis and C. M. Foust. *Gen. Elec. Rev.*, vol. 34, no. 8, Aug. 1931, pp. 452-458, 8 figs. Potential gradients preceding nearby lightning strokes; cloud field gradients during lightning storm; polarity characteristics of breakdown; Lichtenberg figures; protection afforded by lightning rods; variation of Lichtenberg figure streamer length with applied voltage; characteristics of lightning strokes; field records of direct strokes to transmission lines; direct strokes on transmission lines and tripouts; conclusions of analysis.

PROTECTION. Theory and Application of Relay Systems, P. H. Robinson and I. T. Monseth. *Elec. Jl.*, vol. 28, no. 5, May 1931, pp. 299-305, 13 figs. Line-fault protection of loop systems analysis pertaining to fault calculations; application of relays; setting of impedance relays.

RELAYS. Theory and Application of Relay Systems—Gound-Fault Protection of Loop Systems—II, P. H. Robinson and I. T. Monseth. *Elec. Jl.*, vol. 28, no. 7, July 1931, pp. 431-435, 16 figs. Ground-fault currents; application of relays; calculation of ground-fault currents.

Theory and Application of Relay Systems—High-Voltage, Single-Circuit Lines, P. H. Robinson and I. T. Monseth. *Elec. Jl.*, vol. 28, no. 8, Aug. 1931, pp. 485-488, 11 figs. Overcurrent relays; directional-overcurrent relays; directional residual ground relay; polyphase directional-overcurrent relay; fault-detector relay schemes; impedance relay; bus protection; pilot wire relaying; various wiring diagrams are given.

VIBRATIONS. Safeguarding from Vibration, E. C. Thompson. *Elec. Light and Power*, vol. 9, no. 8, Aug. 1931, p. 34, 1 fig. Layout gives idea of work done in installing vibrations dampeners on Jordan Dam-Flomaton line of Alabama Power Co.

Loud Speakers

MEASUREMENT. Notes on Loud Speaker Response Measurements and Some Typical Response Curves, B. Olney. *Inst. Radio Engrs. —Proc.*, vol. 19, no. 7, July 1931, pp. 1113-1130, 10 figs. Difficulties in loud speaker measurements; acoustic features of particular indoor measuring system; outdoor testing arrangements whereby double as well as single radiating loud speakers are measured with negligible ground reflection error; over-all electrical fidelity curve of radio receiver is inadequate performance index; electro-acoustic fidelity embracing frequency response of loud speaker is suggested as more informative.

Machinery

TESTING. Short-Duration Temperature Testing of Electrical Machines, W. E. French. *Instn. Elec. Engrs.—Jl.*, vol. 69, no. 415, July 1931, pp. 867-874, 9 figs. Method for rapid determination of temperature-rise and time-constant of electrical machinery and apparatus, based on exponential heating and Hak curves, tests are produced showing that there is satisfactory agreement between figures and curves of graphical method by short-duration tests and those obtained by measurement from long heat-runs; theory of Hak curve.

Motors

SPEED REGULATION. Motor Applications for Drives Requiring Speed Changes, E. C. Dieffenbach. *Power*, vol. 74, no. 3, July 21, 1931, pp. 80-83, 7 figs. Because of nature of work speed adjustments are essential in multitude of motor drives, ultimate object being to save power and to speed up production; speed variations with motors may be obtained in many ways, 15 methods being discussed.

Musical Instruments

Electronic Musical Instruments, R. Raven-Hart. *Electronics*, vol. 3, no. 1, July 1931, pp. 18-19, and 42, 1 fig. Holding of international congress on subject of electronic music by European inventors and manufacturers of electronic musical devices shows practical extent to which new musical devices have already progressed in Germany, France and other European countries.

Networks

ANALYZERS. Phase Faults Analyzed on D-C. Calculating Board, C. W. Bohner and G. W. Vaughan. *Elec. World*, vol. 97, no. 23, June 6, 1931, pp. 1068-1071, 4 figs. Single-phase-to-ground shorts create unsymmetrical fault currents in phases; paper exhibits technique in ascertaining from direct-current calculating board zero-positive and negative phase sequence components of dissymmetry.

INVERSION. Inversion of System Resulting from Switching Operations, A. Boyajian and W. J. Rudge. *Gen. Elec. Rev.*, vol. 34, no. 7, July 1931, pp. 436-439, 18 figs. Equivalent impedance network of system may be altogether different in character from normal, during various stages of switching operations; usually these are of no particular consequence, but occasionally destructive conditions are encountered; simplest single-phase circuits susceptible of such phenomena are taken as basis for general exploration of phenomena and are applied to three-phase system.

PROTECTION. Installation Protection, T. C. Gilbert. *Elec. Rev.*, vol. 109, no. 2799, July 17, 1931, pp. 93-94, 3 figs. Rheinisch-Westfalisches Elektrizitatswerk has solved problem of usual protective methods in rural conditions by installation of extremely interesting protective devices, both at substations and also on consumer's premises.

TESTING. Automatic Recording of System Disturbances, J. T. Johnson, Jr. *Elec. Jl.*, vol. 28, no. 8, Aug. 1931, pp. 466-468, 6 figs. Multi-element oscillograph gives complete record of currents and voltages during transient, starting from rest within four cycles.

Oscilloscopes

A New Cathode-Ray Oscilloscope, W. O. Osborn. *Elec. Jl.*, vol. 28, no. 5, May 1931, pp. 322-324, 6 figs. Distinctly new type of oscillograph has been developed; with it recurring phenomena, such as wave shapes of voltage or current can be viewed on a fluorescent screen in ordinarily lighted room: yet complete oscilloscope is contained in cabinet about size of suitcase and is readily portable.

Photoelectric Cell

CONTROL. Photoelectric Relays and Monorail System Speed Mail Handling, H. L. Bohm. *Steel*, vol. 89, no. 5, July 30, 1931, pp. 31-33, 4 figs. Photoelectric tube control for monorail conveyor system designed to handle mail bags in railroad terminal.

MOVING PICTURES. Phototube Circuit Design for Sound-Pictures, C. A. Wyeth. *Electronics*, vol. 3, no. 1, July 1931, pp. 22-23 and 44, 5 figs. In selecting most suitable type of phototube to be used in reproduction of sound from film, many factors, both electrical and mechanical, must be considered; chief among electrical factors are frequency response characteristic, sensitivity, impedance and noise level and mechanical factors are shape and size of cell, mounting facilities required, and sturdiness of physical construction.

Power Factor

IMPROVEMENT. Power Factor Improvement, J. Sachs. *AEG Progress*, vol. 7, no. 7, July 1931, pp. 139-145, 17 figs. Relation between active and reactive power; reason for power factor improvement and question as to where and by which means power factor should be improved is considered; design and service characteristics of static condensers; brief review of rotary condensers; various methods of improving power factor of induction motors by three-phase exciters, etc., and synchronous induction motor.

Power Factor Correction by Means of Permittors, A. A. Bolsterli. *Ry. Elec. Engr.*, vol. 22, no. 7, July 1931, pp. 178-180, 3 figs. Physical and economic factors involved in use of static condensers for improving power factor; description of 100-kva., 4,000-volt, 60-cycle permittor; 50-kva., 11,000-volt, 25-cycle permittor used for traction systems.

Poles

WOODEN. Life of Butt-Treated Western Red Cedar Poles, R. M. Wirka. *Elec. World*, vol. 98, no. 6, Aug. 8, 1931, pp. 237-239, 4 figs. Long-time test now under way in vicinity of Los Angeles, Calif., indicates that Western red cedar poles well butt treated with creosote by hot-and-cold-bath process will under such service conditions give average life of at least 25 years; where longer life than 25 years is required under similar conditions top treatment seems necessary; specification of preservatives; table showing condition of experimental Western red cedar poles in and around Los Angeles, Calif., after about 21 to 32 years' service.

STANDARDIZATION. New Standard Specifications for Wood Poles, R. L. Jones. *Bell System Tech. Jl.*, vol. 10, no. 3, July 1931, pp. 514-524, 2 figs. Work of Sectional Committee on Wood Poles of American Standards Assn. covering preparation of specifications for northern white cedar, western red cedar, chestnut and southern pine poles is summarized; major problems underlying development of standard ultimate fiber stresses, standard dimension tables and practical knot limitations are discussed and illustrated by supporting tables or figures.

Power Supply

RURAL. Electricity and the Agriculture of the Next Ten Years, E. A. White. *Agric. Eng.*, vol. 12, no. 8, Aug. 1931, pp. 301-305, 4 figs. Present trend in agriculture and predicted influence of electricity during next ten years. Before Am. Soc. Agric. Engrs.

Radio Antennas

MODULATION. Relations Between Modulation and Antenna Current, W. F. Lanternman. *Electronics*, vol. 3, no. 2, Aug. 1931, p. 59, 1 fig. Mathematical analysis pertaining to increase in antenna current due to power in sidebands; tables show increase in antenna current in relation to per cent of modulation.

SHORT WAVE. Developments in Short-Wave Directive Antennas, E. Bruce. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 8, Aug. 1931, pp. 1406-1433, 23 figs. Relative importance of factors which limit intelligibility of short-wave radio telephone communication; more important of these factors are inherent set noise, external noise (static, etc.), and signal fading; possibility of counteracting these limitations through antenna directivity is indicated; antenna system which maintains desirable degree of directivity throughout broad continuous range of frequencies is described.

The Determination of Power in the Antenna at High Frequencies, A. H. Taylor and H. F. Hastings. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 8, Aug. 1931, pp. 1370-1383, 9 figs. Brief review of general methods of measuring radio-frequency power in antenna; series of tests on particular transmitter operating from 4,000 to 26,000 kc.; tests indicate that it is reasonable for such transmitter continuously variable in frequency and of fairly modern design to be expected to put not less than 50 per cent of its input plate power of last stage into antenna as radio frequency from 4,000 kc. to 8,000 kc. and not less than 32 per cent at 24,000 kv.

Radio Engineering

Experimental Radio Engineering, J. H. Morecroft. N. Y., John Wiley and Sons, 1931, 345 pp., illus., diagrs., charts, tables. $3.50. Laboratory course in principles of radio; 51 experiments are given, designed to bring out characteristics of component parts of receiving and transmitting apparatus, and there is an introduction upon laboratory apparatus. Eng. Soc. Lib., N. Y.

Foundations of Radio, R. L. Duncan. N. Y., John Wiley and Sons, Inc., 1931, 246 pp., illus., diagrs., tables. $2.50. An introductory textbook on electricity, covering in non-mathematical language fundamentals of interest to student of radio engineering. Eng. Soc. Lib., N. Y.

Radio Frequency

MEASUREMENT. Measuring the Frequencies of Radio Signals, A. A. Roetken. *Bell Laboratories Rec.*, vol. 9, no. 12, Aug. 1931, pp. 585-588, 2 figs. By beating incoming radio signal down in successive known steps, its frequency can be accurately determined with audio-frequency oscillator; equipment at Holmdel is illustrated and described.

Radio Receivers

CRYSTAL CONTROLLED. Application of Piezo-Electrical Crystals to Receivers, R. R. Batcher. *Electronics*, vol. 3, no. 2, Aug. 1931, pp. 57-58, 4 figs. Analysis of quartz crystal bridge circuit in intermediate frequency amplifier of super-heterodyne receiver and development of simple relation between degree of unbalance and impedance of quartz crystal and holder which governs response of bridge as whole; it is shown that almost all of one sideband is eliminated but that other gets through to transmit desired modulation.

Radio Waves

ATTENUATION. Investigation of the Attenuation of Electromagnetic Waves and the Distances Reached by Radio Stations in the Wave Band from 200 to 2,000 Meters, H. Fassbender, F. Eisner and G. Kurlbaum. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 8, Aug. 1931, pp. 1446-1470, 25 figs. Results of large number of field strength measurements in which relative radiation characteristics of transmitting and receiving stations remain constant even on changing their distance; constant of attenuation as function of wavelength was determined for propagation of waves over land from these measurements; method used eliminates errors in absolute determination of received field strength.

PROPAGATION. Radio Transmission Studies of the Upper Atmosphere, J. P. Schafer and W. M. Goodall. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 8, Aug. 1931, pp. 1434-1445, 9 figs. Number of measurements which show time variations in virtual height of ionized regions of upper atmosphere; these measurements were usually made simultaneously on two frequencies, 1,604 kc. and 3,088 kc.; single frequency data are also given; main points of interest are presented.

Railroad

SIGNALS AND SIGNALING. Positive Control by the new Quebec Tunnel Signal System, E. S. Taylor. *Elec. News*, vol. 40, no. 15, Aug. 1, 1931, pp. 39-40, 4 figs. Mile-long tunnel has just been completed by Canadian Pacific Railway as direct link between its main line and new round-house for its great White Empresses, at Wolfe's Cove, Quebec; one of interesting features of this new project is unique and modern signal system for safety and guidance of trains into and out of Quebec, and also for those which use tunnel; system is briefly described.

Indianapolis Union Station Installs Electro-Pneumatic Interlocking. *Ry. Signaling*, vol. 24, no. 8, Aug. 1931, pp. 265-268, 6 figs. Nearly 200 train movements each day are now made with greater safety and flexibility; features of interlocking machine, signals, field apparatus, power supply and air supply.

Centralized Traffic Control Installed on Wabash. *Ry. Signaling*, vol. 24, no. 7, July 1931, pp. 231-236, 7 figs. Outstanding features of centralized control traffic installation on 37 mi. of single track line on Wabash railway between LaFayette Junction, Ind., and State Line; track layout and traffic; dispatcher's machine 93 mi. from distant end of 37 mi. single-track installation; operating savings justify cost; special signal requirements; power supply system.

New Interlocking on the Toronto, Hamilton and Buffalo at Hamilton, Ont. *Ry. Signaling*, vol. 24, no. 7, July 1931, p. 245, 5 figs. Old layout replaced by 72-lever plant; new cable distribution constructed under traffic without stopping train; interlocking machine and tower.

New Interlocking for the St. Louis Municipal Bridge. *Ry. Signaling*, vol. 24, no. 8, Aug. 1931, pp. 280-282, 5 figs. Simplicity of circuit arrangement and unique tower are features of 64-lever electric plant; battery and power room; relay room.

Interlocking. *Am. Ry. Signaling Principles and Practices*, Chapter 16, 1931, 65 pp., 43 figs. Definitions; types; historical review; application; track layout; layout and operating features of inside apparatus; 361 questions dealing with interlocking.

SUBSTATIONS. Habitant Style Disguises City of Montreal's Latest Automatic Railway Substation. *Elec. News*, vol. 40, no. 15, Aug. 1, 1931, pp. 31-32, 4 figs. Fourth mercury-arc rectifier substation installed by Montreal Tramways Co. contains two 1,500-kw., 12-phase, 600-volt units; station and equipment are described.

Rate Making

POWER INDUSTRY. A Composite Block Tariff, L. G. Hill. *Elec. Rev.*, vol. 109, no. 2798, July 10, 1931, p. 47, 3 figs. Lack of suitable standard tariff is probably greatest obstacle to domestic electrical development; what engineer has to pay for his bulk supply and how best these charges can be applied to domestic consumers; teaching the consumer to think in terms of hundreds of kilowatt-hours.

Reactors

CURRENT LIMITING. Development of Large Current-Limiting Reactors, R. B. George. *Elec. Jl.*, vol. 28, no. 8, Aug. 1931, pp. 460-463, 10 figs. Design development and testing procedure of dry-tube and oil-immersed current-limiting reactors; increased reactor sizes.

Rectifiers

MERCURY ARC. Mercury-Arc Rectifiers, W. E. Gutzwiller. *Power*, vol. 74, no. 2, July 14, 1931, pp. 44-47, 6 figs. Analysis of rectifier performance compared with that of synchronous converters and motor-generator sets.

VOLTAGE REGULATION. Voltage Regulation in Rectifier Plants, N. Kotschubey. *Brown Boveri Rev.*, vol. 18, no. 7, July 1931, pp. 223-233, 22 figs. By production of new tapping switches permitting number of steps to be increased up to 60, it was possible to limit use of induction regulators to infrequent cases; automatic control of such tapping switches greatly simplifies operation of rectifier plants, thus enabling important savings to be made.

Registration

Important Changes Proposed in Uniform Registration Law, T. K. Legare. *Eng. News-Rec.*, vol. 107, no. 7, Aug. 13, 1931, pp. 266-267. President, National Council of State Boards of Engineering Examiners, recommends definite educational qualifications for professional engineers and land surveyors; satisfactory definition of engineering sought.

Steam Electric Plants

HIGH PRESSURE. Station "A" Initiates Use of High-Pressure Steam in the West, W. G. McKay and C. E. Steinbeck. *Elec. West*, vol. 67, no. 2, Aug. 1, 1931, pp. 68-71, 3 figs. Boiler pressures of 1,400 lb. are used in new steam station of Pacific Gas and Electric Co. in San Francisco; 100,000 kva. is generated by two turbine-generator sets recently installed to supply increased energy requirements of Bay area.

Steel Corrosion

UNDERGROUND. The Electrolytic Corrosion of Underground Metallic Structures by Stray Currents, C. M. Longfield. *Instn. Engrs. Australia—Jl.*, vol. 3, no. 5, May 1931, pp. 157-168, 21 figs. Nature of electrolysis of subsurface structures and conditions bringing it about; discussion of field surveys, results obtained, and to what extent observed phenomena can be used as estimation of damage; remarks about instruments for use in field, and in particular of slow speed oscillograph adapted by author; mitigative measures are critically discussed; importance of protective coatings for steel mains is stressed.

Substations

AUTOMATIC. 10 Years' Experience with Automatic and Supervisory Distribution Substations, F. F. Ambuhl. *Elec. News*, vol. 40, no. 15, Aug. 1, 1931, pp. 35-37 and 51, 5 figs. Toronto Hydroelectric System has long realized advantages and economies of automatic and supervisory control; as result, all new stations built since 1920 have been designed for either automatic or supervisory control; automatic controls have given fairly satisfactory results and supervisory controls have given excellent results, especially cable type supervisory. Before Am. Inst. Elec. Engrs.

REMOTE CONTROL. Synchronism Checked by Voltmeter, F. M. Lewis. *Elec. World*, vol. 97, no. 23, June 6, 1931, p. 1056, 1 fig. Northwestern Electric Co. completed substation in business district of Portland which will be remotely controlled until station becomes large enough to require an operator; to save expense of installing additional control wires; synchroscopes; synchronizing switches or synchroverifier relays; special voltmeter connection for checking synchronism between line and bus was made.

Visicode Supervisory Control, L. J. Cissna. *Elec. Jl.*, vol. 28, no. 7, July 1931, pp. 424-425, 3 figs. Visicode provides remote control of equipments in several distant stations with continuous indications for each piece of apparatus controlled, over only two line wires, and also makes possible selective remote-metering indications over same two wires used by supervisory control, as well as operation of number of remote stations in parallel on same two wires; most important feature of visicode is that it reduces line wire costs to minimum not possible with previous three- and four-wire designs.

Switchgear

METAL-CLAD. Guide for Specification Covering Metal-Clad Switchgear. *Nat. Elec. Light Assn.—Pub.*, no. 149, July 1931, 3 pp., 1 fig. Guide is primarily intended to serve as reminder of points to be covered when purchasing equipment and as indication of logical order in which they should be enumerated; five different unit standards are presented.

Synchronizers

AUTOMATIC. A Thermionic Automatic Synchronizer, F. H. Gulliksen. *Elec. Jl.*, vol. 28, no. 7, July 1931, pp. 421-423, 4 figs. New synchronizer requires but five volt-amperes per transformer for its operation, which is well within limits of energy which can be drawn from potential devices, making transformers unnecessary; this makes possible automatic synchronization in some applications where it was not previously justified economically; synchronizer uses two thermionic tubes which, because they are in use only during synchronization, have life of five to ten years.

Telephone

AUTOMATIC. Dial Offices for Small Communities, F. T. Meyer. *Bell Laboratories Rec.*, vol. 9, no. 12, Aug. 1931, pp. 562-566, 5 figs. Adaptation of improved telephone equipment to smaller communities, especially those more or less isolated from larger operating centers, has been greatly facilitated by development of new dial office of step-by-step type; equipment is described in some detail.

The Bypath Automatic Telephone, E. P. G. Wright and J. H. E. Baker. *Post Office Elec. Engrs.—Jl.*, vol. 24, pt. 2, July 1931, pp. 116-124. Bypath system is universal automatic telephone system employing single motion switches (or uniselectors) of simple design; development of system has been carried out entirely in London and is outcome of unremitting research work extending over number of years resulting in production of system which, in opinion of authors, is superior to other step-by-step systems; in this class it achieves standard of efficiency hitherto unattained.

DIAPHRAGM MEASUREMENT. Recording Contour Gauge, E. C. Erickson. *Bell Laboratories Rec.*, vol. 9, no. 12, Aug. 1931, pp. 567-570, 6 figs. Equipment for measurement of quality and adjustment of diaphragm; photographic record of two diaphragms are given.

LONG DISTANCE. Speed of Service on Long Distance Calls, C. Bryon. *Telephony* vol. 101, no. 3, July 18, 1931, pp. 25- and 28-29, 1 fig. Average time required to complete toll call is 1.6 min. compared with eight min. in 1926; some principles for obtaining and maintaining speed of service. Paper before Annual Traffic Conference, III.

RELAYS. Characteristics of Strowger Relays—III, K. W. Graybill. *Telephone Engr.*, vol. 35, no. 7, July 1931, pp. 32-33, 3 figs. Various methods used to determine mechanical adjustment values of horizontal relays; reference tables governing these values.

REPEATERS. Repeaters for Two-Wire Toll Circuits, R. L. Case. *Bell Laboratories Rec.*, vol. 9, no. 12, Aug. 1931, pp. 579-584, 10 figs. Twenty-one type repeater employs but single amplifying element and is limited in its use by requirement that lines in opposite directions must balance each other; employment of balancing networks and two amplifying element results in broader applicability of 22-type repeater; simplified schematic diagram of 22-A-1 repeater; loss-frequency characteristics and gain-frequency characteristics of equipment described are given.

Negative Impedances and the Twin 21-Type Repeater, G. Crisson. *Bell System Tech. Jl.*, vol. 10, no. 3, July 1931, pp. 485-513, 16 figs. Negative resistances and impedances; their properties and some devices by which they may be produced physically; certain properties of negative impedances when used as series and shunt boosters for amplifying speech waves in telephone circuits; description of circuit and properties of twin 21-type repeater.

STATISTICS. World's Telephone Statistics, January 1, 1930. *Bell Telephone Quarterly*, vol. 10, no. 3, July 1931, pp. 138-149, 7 figs. Statistical data, tables, curves and maps.

TESTING. Automatic Testing Equipment for Trunk Circuits, T. R. Lundius. *Bell Laboratories Rec.*, vol. 9, no. 12, Aug. 1931, pp. 589-592, 2 figs. To make sure that supervisory relays are functioning properly they are frequently tested, and since there are large numbers of them to simplify and quicken procedure, automatic circuits have recently been developed which operate relays under conditions more severe than are ordinarily met in service.

Television

PICK-UP. Television Direct Pick-up Camera, D. W. Short. *Electronics*, vol. 3, no. 2, Aug. 1931, p. 69, 1 fig. Novel method of "picking up" television images is made possible by means of direct pick-up camera; this device differs from indirect pick-up method or so-called flying spot equipment, inasmuch as image of person or object being televised is focused directly upon spiral number one of scanning disk.

Transformers

CONSTANT CURRENT. Simple Automatic Time Control for Constant-Current Transformers, W. H. Colburn. *Elec. World*, vol. 98, no. 5, Aug. 1, 1931, pp. 202-203, 3 figs. Control described has been devised to meet following operating requirements; start at predetermined time and continue to operate until cut out, at predetermined time; cut out and lock out individual transformer or main breaker in event of electrical failure in one or in totality circuit; etc.

EXTINGUISHING COILS. Determination of the Rating of Extinguishing Coils Which May Be Connected to Transformers, A. van Gastel. *Brown Boveri Rev.*, vol. 18, no. 8, Aug. 1931, pp. 251-259, 14 figs. Design analysis, diagrams, characteristics and equations.

Vacuum Tubes

CONSTANTS. Graphical Representation of the Three Constants of a Triode, I. Miura. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 8, Aug. 1931, pp. 1488-1491, 2 figs. It is shown that three constants of triode, e. e., amplification factor, internal resistance, and transconductance can be represented by one point in equilateral triangle logarithmically scaled; as example, graph in which are plotted constants of 24 kinds of typical tubes now used in practise is given.

PENTODES. Performance of Output Pentodes, J. M. Glessner. *Inst. Radio Engrs.—Proc.*, vol. 19, no. 8, Aug. 1931, pp. 1391-1405, 17 figs. Comparison of power output, distortion, power sensitivity, and a-c./d-c. power economy of group of experimental pentodes is made with corresponding triodes; apparatus and method of measuring are described; pentodes' a-c./d-c. economy and power sensitivity is considerably higher than that of correspond in g triodes; harmonic distortion is found to be generally worse with pentodes; variation in power output with changes in load resistance, arbitrarily called "output distortion," is shown to be about same for both classes of tubes.

ULTRA SHORT WAVE. Tubes for Generating 18-cm. Waves. *Electronics*, vol. 3, no. 1, July 1931, p. 4, 1 fig. Photograph of tube used in transmission of radio phone communication across English channel by means of directive wave of order of 18 cm. published for first time.

VOLTAGE REGULATORS. Tube Voltage Regulator Eliminated Hunting Tendency, F. H. Gulliksen. *Elec. World*, vol. 98, no. 4, July 25, 1931, pp. 162-163, 2 figs. Thermionic type voltage regulator for d-c. generators has recently been developed, by which anti-hunting force should be proportional to rate of recovery of regulated voltage, and must be zero when regulated voltage is normal at any generator load; anti-hunting adjustment should be simple and independent of adjustment for regulated voltage and regulator response.

Watt-Hour Meters

BEARINGS. An Investigation of Problems Relating to the Use of Pivots and Jewels in Instruments and Meters, V. Stott. *Instn. Elec. Engrs.—Jl.*, vol. 69, no. 414, June 1931, pp. 751-756, 13 figs. Results obtained in investigation of problems arising in connection with use of pivots and jewels for bearings; means adopted for obtaining accurately shaped pivots and for measurement of pivots and jewels; method of measuring hardness and determining suitable radii of curvature.

CALIBRATION. Determining Large Three-Wire Lighting Meter Constants, H. W. King. *Elec. World*, vol. 98, no. 5, Aug. 1, 1931, pp. 201-202, 7 figs. Simple but infallible method of determining or checking dial constants in cases where self-contained meters with dial constant equaling one, may be used with current transformers and then have new multiplying constant assigned and marked on dial in meter shop.

Waves

ANALYSIS. High-Voltage Surge Testing, P. H. McAuley. *Elec. Jl.*, vol. 28, no. 5, May 1931, pp. 278-280 and 305, 10 figs. Analysis of laboratory data; interpretation of oscillograms; time lag of breakdown; obtaining time-lag curves from oscillograms; laboratory data required.

Welding

Twenty-Five Years of Electric Welding, P. W. Fassler. *Am. Welding Soc.—Jl.*, vol. 10, no. 5, May 1931, pp. 29-35, 8 figs. History of welding; fundamental thermal and electrical laws which have vital bearing on design of welding machines; butt welding; spot welding; relief welding; seam welding.

ARC. Automatic Arc-Welding; Its Advantages and Limitations, A. M. Candy. *Elec. Jl.*, vol. 28, no. 7, July 1931, pp. 415-417, 6 figs. General outline of process and equipment.

ARC—ATOMIC HYDROGEN. High Tensile Atomic Hydrogen Arc Welds in Alloy Steels, F. Ray. *Am. Welding Soc.—Jl.*, vol. 41-45, 11 figs. Welding procedure in making Flexo Disc expansion joint which consists of steel bellows constructed of corrugated steel, discs welded together at their inner and outer peripheries; properties of weld.

BOILER MANUFACTURE. Attitude of Eleven Utilities Toward Welded Boilers. *Elec. World*, vol. 97, no. 21, May 23, 1931, pp. 955-957, 1 fig. N. E. L. A. prime movers committee has given welded boiler drums and tubes considerable study and A. S. M. E. boiler code committee is now engaged in formulating code that permits such construction; several utility executives and engineering or operating department heads were asked three questions treated later to ascertain possible trend of welded boiler acceptance and also what active cooperation might be expected from users in bringing about code acceptance.

PIPE LINES. Design for Welded Piping, A. G. Wikoff. *Am. Welding Soc.—Jl.*, vol. 10, no. 5, May 1931, pp. 26-28, 9 figs. Standard designs for various types of joints recommended for welded piping systems; developed by Linde Air Products Co.; open single vee butt welds; open square butt weld; closed single vee butt weld; welded coupling; butt weld with thin liner; special reinforced joints.

Welding Machines

ARC. The Burke-Scott Electric Welder. *Engineer*, vol. 152, no. 3939, July 10, 1931, p. 48, 2 figs. Although primarily intended for arc welding, it may be used for other purposes that call for similar operating characteristics; machine may be regarded as one in which main pole parts are split into two parts, one part being shunt-wound and other series-wound.

Welds

GAMMA RAY ANALYSIS. Inspection of Welds with Gamma Rays, G. E. Doan. *Am. Soc. Steel Treating—Preprint*, no. 34 for mtg. Sept. 21-25, 1931, 8 pp., 5 figs. Gamma-ray method gives adequate results for inspection of welds, according to tests made by author at Lehigh University; tests on good welds and bad welds revealed each kind without fail; not only were defects plainly visible in bad welds, but good welds were revealed as sound, in each case.

X-RAY ANALYSIS. X-Ray Inspection of Welds, H. R. Isenburger. *Am. Welding Soc.—Jl.*, vol. 10, no. 5, May 1931, pp. 17-21, 15 figs. Inspection methods and equipment of St. John X-Ray Service Corp., New York; diagram of exposure technique for small tubing inspection; diagram of fluoroscopic x-ray inspection; operating cost is $3 to $5 per hour.

Industrial Notes

A New Clip-On Ammeter.—Ferranti Electric, Limited, Toronto and New York, has developed a new instrument known as the Clip-On Ammeter, which may be used for determining the actual loading of transformers, for balancing secondary transformer loads on three-wire services, or for checking power consumers' loads. It will also be of value to electrical contractors and plant electricians in determining actual loads taken by individual motors, or balancing loads on different circuits or feeders. It consists of a split-core current transformer with the secondary connected to a high grade, well damped Ferranti milliammeter calibrated for direct reading in amperes. The operating handle is well insulated. Good accuracy is provided even at low currents because of the low burden of the meter, which is only 0.22 voltampere. This is a feature not found in any other typ eof such equipment.

This instrument affords a rapid and convenient method of measuring the current in any a-c. leads or bus-bars without disconnecting them for the insertion of the usual current transformer or ammeter leads. The meter has a double range, one scale being 0-100 amperes and the other 0-500 amperes. A switch on the meter changes the reading from one scale to the other. The instrument is light and can be operated easily with one hand.

Ohio Brass Promotes H. H. Crow.—Announcement has been made by the Ohio Brass Company, Mansfield, Ohio that H. H. Crow, with headquarters at the New York office, is now in charge of its sales territory in upper New York state. He will handle the sale of high tension insulators and electrical porcelain to the power companies in that locality.

Oil-Blast Principle Applied to Low Capacity Breakers.—The General Electric Company has announced a new line of triple-pole circuit breakers for outdoor service designated Type FKO-60. These breakers can be furnished mounted on self-supporting steel framework or for pole-mounting, and for manually-, solenoid-, or motor-operated requirements. The interrupting rating is 50,000 kva., equipped with blade-and-finger contacts, using the plain-break principle of arc interruption. Each pole is in a separate oil tank. The Types FKO-60B and FKO-60C breakers have interrupting ratings of 100,000 and 175,000 kva. respectively. They have separate oil tanks for each pole and operate on the oil-blast principle. An insulating chamber is fitted within each tank. In each chamber an exhaust port is located adjacent to one of the breaks in each phase. A pressure is set up within the oil by the arcing of the contacts. The only vent for this oil under pressure is through the exhaust port.

An Improved Type of Switchboard Matting.—The Diamond Rubber Company, Akron, Ohio, announces an improved insulation matting for use as a protection to the operators of power switchboards, that is guaranteed when tested in accordance with the methods prescribed in American Society For Testing Materials Specification D-178-24, to withstand the following tests: Voltage Test—Thicknesses of 1/8″, 3/16″, 1/4″ and 3/8″ will withstand a potential of 15,000 volts for one minute when tested between electrodes consisting of rectangular metal sheets or plates 9″ x 15″ in size, or of equivalent area. Dielectric Test—When a section of the matting is tested in air between disc electrodes 2″ in diameter, it is guaranteed to withstand the following voltage: 1/8″ thickness 20,000 volts; 3/16″ 30,000 volts; 1/4″ 40,000 volts; 3/8″ 45,000 volts. The matting is made with six laminations of high grade rubber, and a ply of fabric to give additional strength.

New Protective Feature for Street Lighting Lamps.—The Westinghouse Lamp Company announces the development and perfection of a protective short-circuiting device, the "Inbuilt Cutout" which, supplemental to the regular construction, may be built into the base of Mazda incandescent lamps designed for burning on series circuits. In addition to the greater convenience of relamping after burnout, lamps with Inbuilt Cutouts possess two notable advantages—

First, it serves as a completely reliable means for quenching the arc which, upon burnout of the filament, has occasionally persisted. In rare instances such arcs have continued to a point where the socket and even the post top has been destroyed. Second, because it operates with lesser variation from designed breakdown voltage than is the case with short-circuiting filaments, discs or materials heretofore employed, the Inbuilt Cutout makes it possible successfully to operate small series circuits of only a few lamps. This is sometimes of considerable advantage in supplying street lighting service for newly added, outlying territories.

Gilbert Gislason Joins U. S. Magnetic Products Corp.—According to a recent announcement, Gilbert Gislason has been appointed special representative of the Great Lakes District and also in upper New York State, for the U. S. Magnetic Products Corp., Lock Haven, Pa., manufacturers of coil windings, solenoids, transformers, etc. Mr. Gislason was previously connected with the Easton Coil Co., Easton, Pa., and in his new connection he again becomes associated with N. L. Dinion. A few months ago Mr. Dinion resigned as president of the Easton Coil Co., to become vice-president of the U. S. Magnetic Products Corporation.

Kester Solder Opens Canadian Plant.—The Kester Solder Company has announced the opening of a new plant at Brantford, Canada, on September 15. The plant will be operated under the name of Kester Solder Company of Canada, Ltd. Other factories are located at Chicago and Newark, N. J.

Trade Literature

Lava.—Bulletin, 24 pp. Describes lava and magnesia specialty insulation. This material has very high dielectric strength and will withstand extremely high temperatures. It is widely used by electrical manufacturers as an insulator in many forms. Lava products are produced with the same degree of accuracy and interchangeability as those of a screw machine and without the necessity of first making dies or molds. American Lava Corporation, 27 William St., Chattanooga, Tenn.

Motor Starter.—Bulletin, 4 pp. Describes a new EC&M oil-immersed starter for motors of large horsepower. Like the No. 1 type ZO starter, this larger starter is a self-contained unit, totally enclosed in a heavy pressed steel case with oil-immersed main and control circuit contacts, and vapor-proof overload relays. If desired, installation of such starters can safely be made alongside the motors controlled. The Electric Controller & Mfg. Company, 2700 East 79th Street, Cleveland, Ohio.

Celoron Gears.—Bulletin, 28 pp. Describes Celoron silent gears and illustrates their application in various types of machinery. Continental-Diamond Fibre Company, Newark, Delaware.

Trimming Board.—Bulletin. Describes a new and improved cutter for use in drafting rooms, engineering schools, and for cutting insulating materials or other sheet materials. An automatic hold-down clamp works through the movement of the 26-inch blade in advance of the shearing. No wood is employed in the construction, the top being of Bakelite with engraved quadratic lines one inch apart over its entire surface. Bosch Products Company, San Francisco, and 370 Lexington Ave., New York.


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The careful investor judges a security by the history of its performance.
KERITE
in three-quarters of a century of continuous production, has established a record of performance that is unequalled in the history of insulated wires and cables.
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DAYS KERITE
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THE KERITE INSULATED WIRE & CABLE COMPANY INC
NEW YORK CHICAGO SAN FRANCISCO

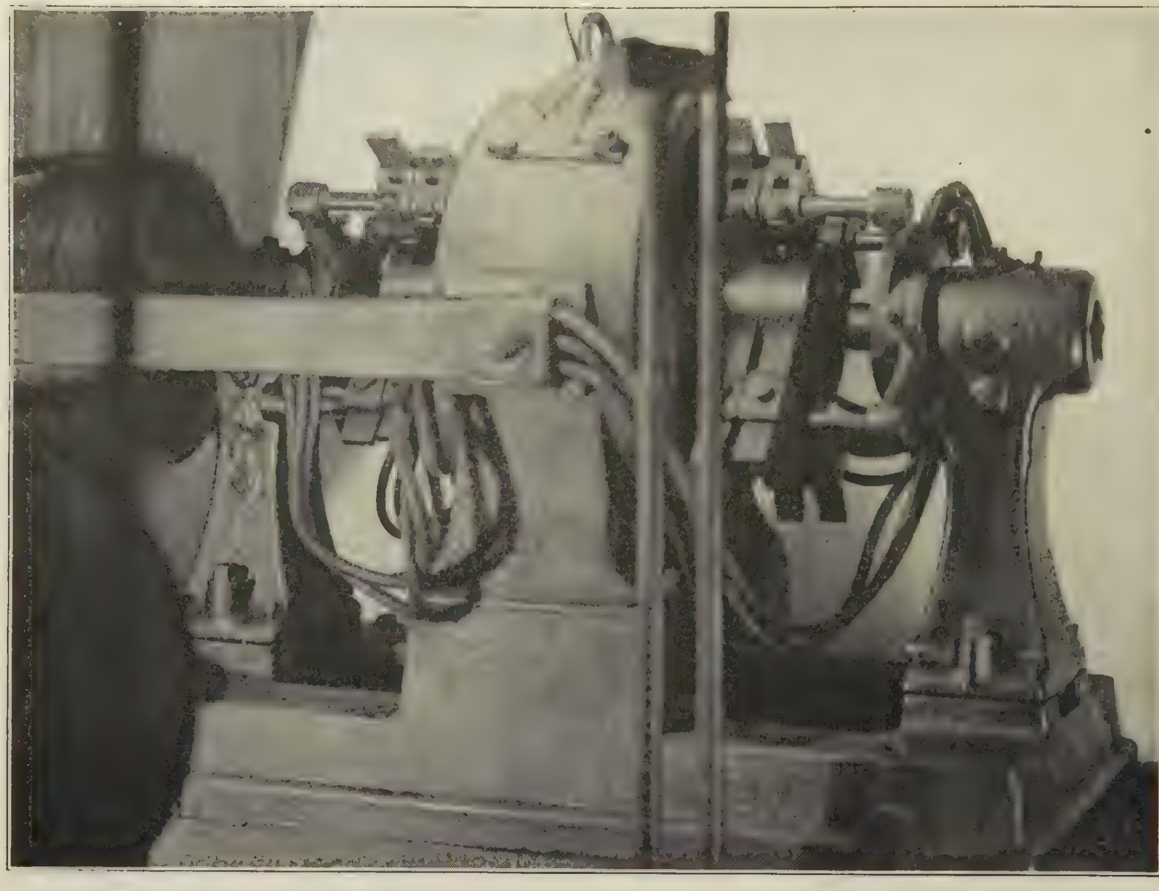
Model
1904

1000
amperes

6
volts

660
r. p. m.

in
service
since
February
1905



Model
1909

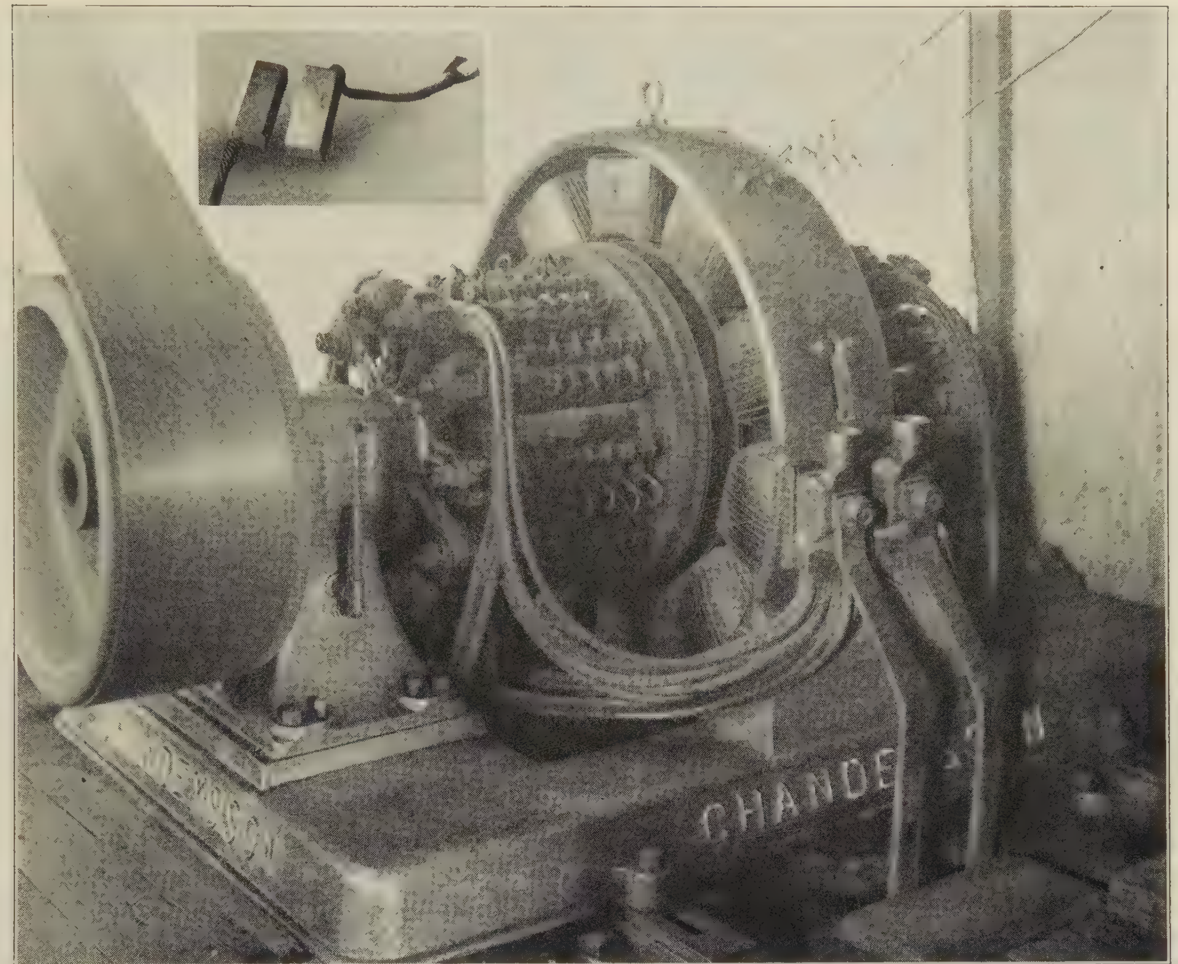
1500
amperes

9
volts

450
r. p. m.

as it
looks
today

Both of these generators operate regularly with original commutator, bearings, and windings



Model 1916 4000 amperes 6 volts 360 r. p. m.

This generator has been in service since early 1920. Not only are the bearings, windings, and other parts in perfect condition but the brushes and commutators show scarcely any wear. At the present rate, one hundred years' life for the brushes and the commutators would be a most conservative estimate.

Note an old brush with over 11 years' wear by the side of a new brush the corners of which have not been chamfered to fit the brush holders and which of course has not been sand papered to fit the commutator.

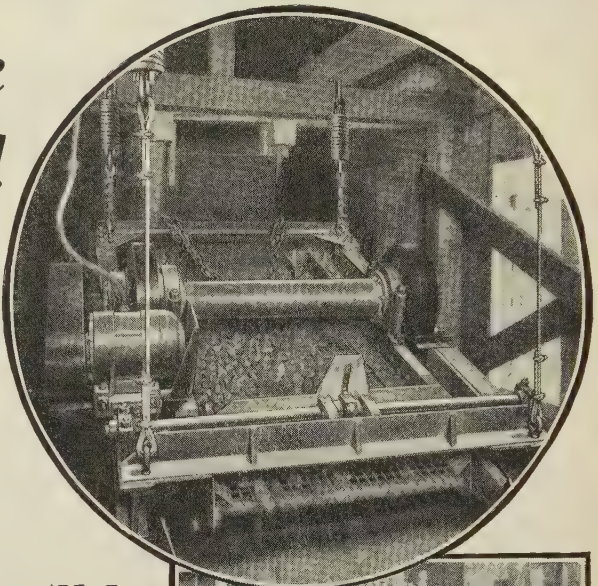
Anybody can receive additional facts and information by addressing . . .

Chandeysson Electric Company

St. Louis, Missouri

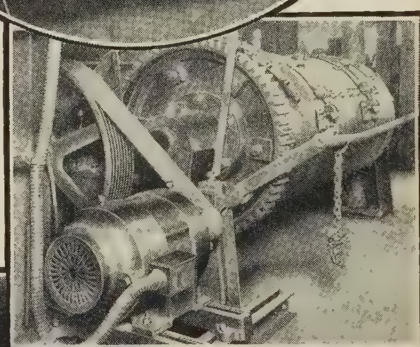
Ask Your Maintenance Man!

..*where the troublesome drives in your plant are!*

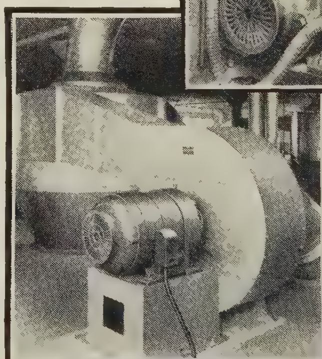


Ask him where dust, dirt, moisture, dripping water, or even destructive gases are present. Those drives in out-of-the-way places, where motor windings become clogged or moisture soaked. . . . Ask him to study the Allis-Chalmers Enclosed Fan-cooled Motors, approved by the Underwriters for dusty locations, and where explosive gases are present. . . . Ask him to notice how these motors have the same sturdy construction, liberal design, and unexcelled insulation, that for years have been characteristic of Allis-Chalmers motors. . . . Ask him to note also, how these enclosed fan-cooled motors are as easily accessible, and with no greater number of parts, than a standard open motor. . . . Ask him to write for Leaflet 2124, on the Enclosed Fan-cooled Motor, and Leaflet 2125A, on the Explosion-proof Motor.

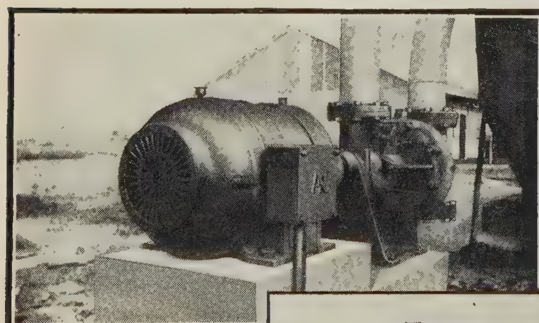
Type ARZ Enclosed Fan-cooled Motors are used on all Allis-Chalmers Centrifugal Vibrating Screens because these motors are best protected against dust, dirt and water.



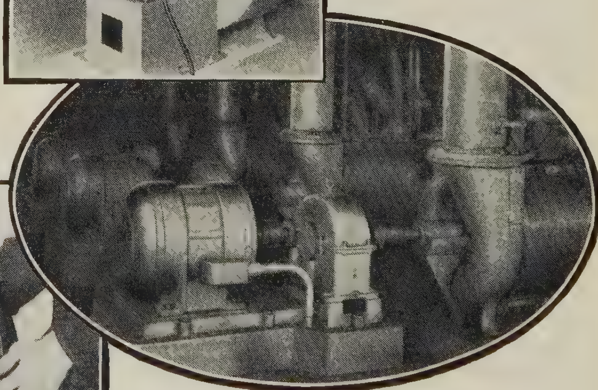
Even in a foundry atmosphere laden with iron dust and fine sand, type ARZ Motors operate without trouble. This motor operates a tumbling barrel for cleaning small iron castings.



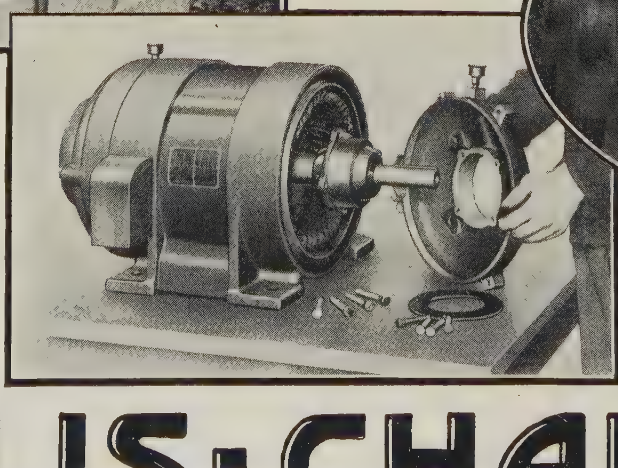
Right — ARZ motor driving fan in a starch mill where fine dust is always present and enclosed motors are necessary for safety of operation.



Left—Type ARZZ Explosion Proof Motor driving gasoline pump in Texas refinery. This motor saved the cost of a building and fire wall.



ARZ Motors driving rotary stock screens in a southern paper mill. This mill uses 15,000 h.p. of Allis-Chalmers motors, many of them enclosed as protection against gases, acids and water.

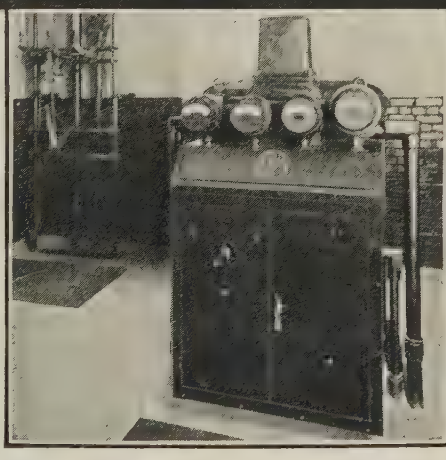


Allis-Chalmers Enclosed Fan - Cooled Motors are as readily accessible as those of the open type.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee

Dependable Control For Fan Drives . . . .



THE illustration to the right shows an EC&M 500 H.P., 2300 Volt Unit-type Synchronous Motor Starter that controls the motor driven fan shown in the large illustration above.

There is no other synchronous motor control equipment built like this EC&M Automatic Starter. It is complete in every respect containing all the necessary equipment such as meters, transformers, and main and field switching mechanisms in a single, completely wired, totally enclosed, oil-immersed unit. This unit construction provides a material reduction, not only in the installation cost but also in the time required for installation, because you need only set the unit on the floor and connect the line and motor leads to the terminals. Since no live parts are exposed, grounding the enclosing case also makes the installation shock-proof.

The starting of this motor is very simple and is accomplished with the utmost safety to operator, motor and driven machinery. By merely operating a low voltage master switch, this EC&M Automatic Starter starts, accelerates and synchronizes the motor with far greater safety and skill than human hands could do it. Being oil-immersed, the starter is always ready for operation—always well lubricated and protected against moisture and corrosion. This means that only an occasional inspection of the contacts is necessary to secure the dependable performance that means a continuous supply of fresh air at all times and under all conditions. Ask for Bulletins 1042-G, 1047-A and 1062 completely describing these unit-type motor starters.

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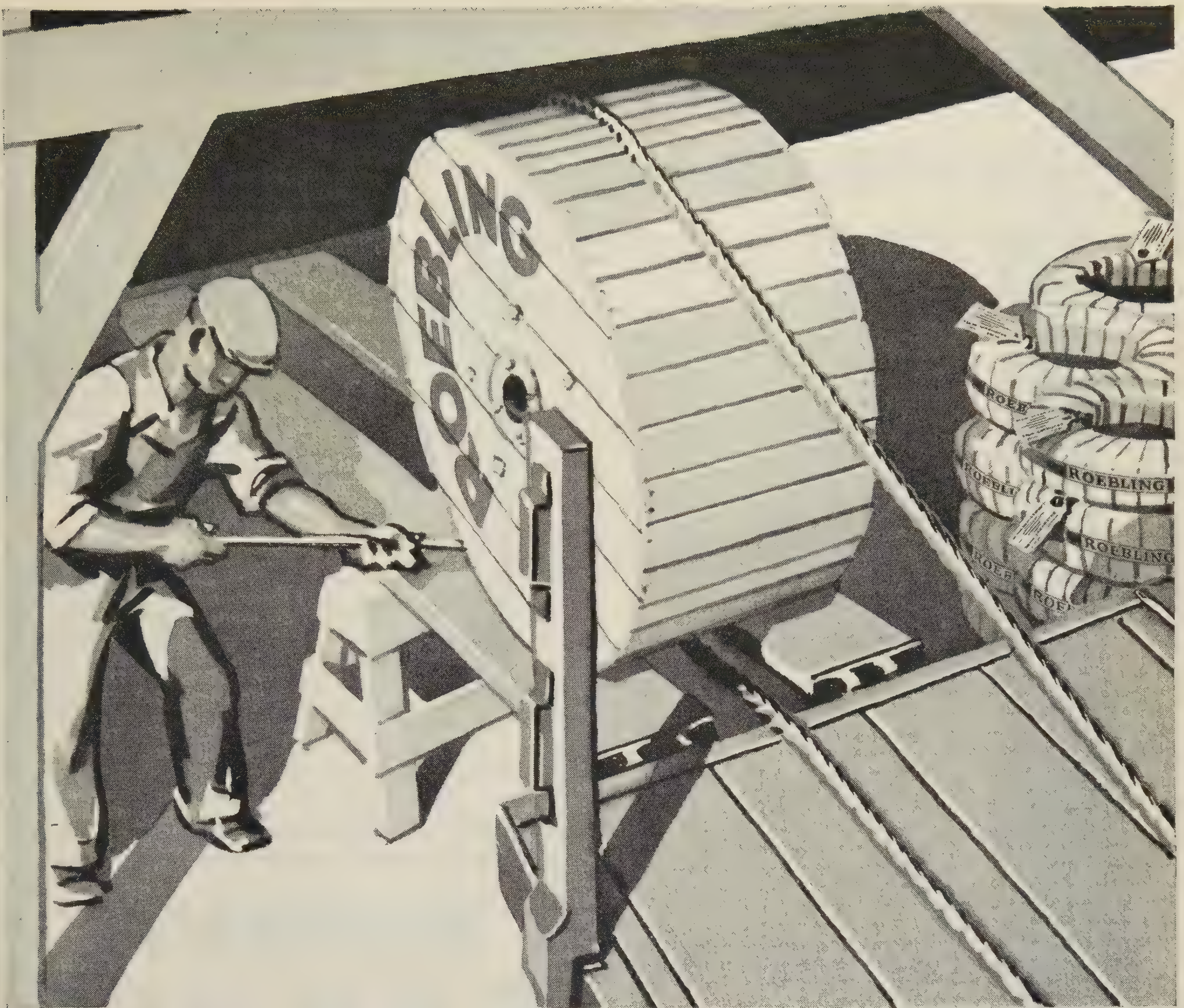
ROEBLING
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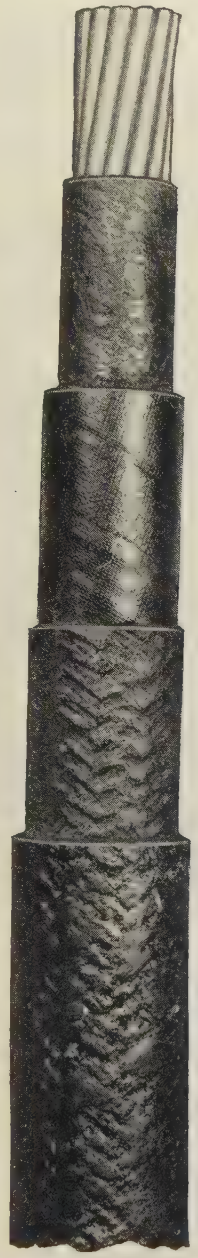
How to Avoid Power Cable Failure



SOME engineers having occasion to use some of the smaller ROCKBESTOS wires such as magnet wire, may not realize that ROCKBESTOS makes cables up to 2,000,000 C.M. and for voltages up to 7500.

A number of central stations, steel mills, cement plants and large industrial plants in other lines are using these cables wherever it is necessary to place power feeders in hot locations or where other deteriorating conditions make it desirable to use a non-deteriorating insulated cable to insure uninterrupted service.

The ROCKBESTOS A.V.C. insulation on these cables is a combination of non-deteriorating felted and impregnated asbestos sheath over and under high grade varnished cambric of the proper thickness for the voltage involved.

The cambric is hermetically sealed away from air and the entire insulating wall is permanently flexible even under continuous high temperatures.

The combination insulating wall is surmounted by the usual tough, braided asbestos jacket, finished with flame-proof and moisture-proof insulating cements.

Here is a cable that can be installed to stay—permanently. ROCKBESTOS A.V.C. cables of this type are operating under conditions that have ruined ordinary insulated cables.

Let us supply you with a sample and more information. There's no obligation. Send the handy coupon today.

ROCKBESTOS PRODUCTS CORPORATION
394 NICOLL STREET NEW HAVEN, CONN.

ROCKBESTOS—*the wire with permanent insulation*

ROCKBESTOS PRODUCTS CORP., 394 Nicoll St., New Haven

Yes, let me have the sample and information. No obligation, of course.

Name..

Title..

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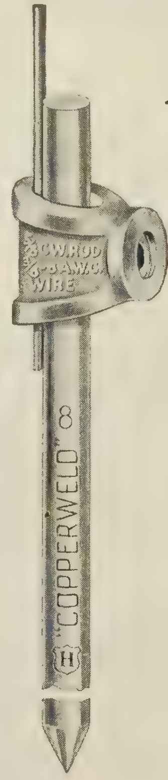
"COPPERWELD" Ground Rods and Ground Clamps Are a Proven Standard



Every Copperweld Ground Rod is a rigid, one-piece rod, pointed, ready for driving with a light hammer.

They are rigid because of the electric furnace steel core. They are non-rusting because the heavy copper exterior is molten-welded to the steel core.

The Copperweld Grounding Clamp is quickly and easily installed. It maintains a tremendous pressure on the copper-to-copper connection between the grounding wire and the Copperweld rod.

Copperweld Steel Company
Glassport, Penna.

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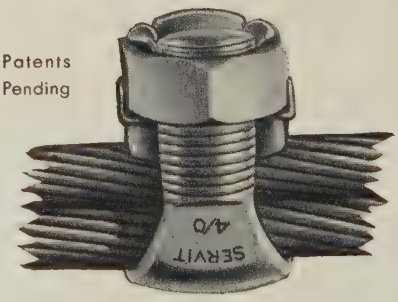

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locking, two-piece, drop-forged, copper Service Connector

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- Westinghouse Elec. & Mfg. Co., E. Pittsburgh

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- Westinghouse Elec. & Mfg. Co., E. Pittsburgh

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Weston Elec. Inst. Corp., Newark, N. J.

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Roller-Smith Co., New York
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Weston Elec. Inst. Corp., Newark, N. J.

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Roller-Smith Co., New York
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General Electric Co., Bridgeport, Conn.
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West Va. Pulp & Paper Co., New York

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Okonite Co., The, Passaic, N. J.
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Mica Insulator Co., New York
Minerallac Electric Co., Chicago
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Porcelain Insulator Corp., Lima, N. Y.
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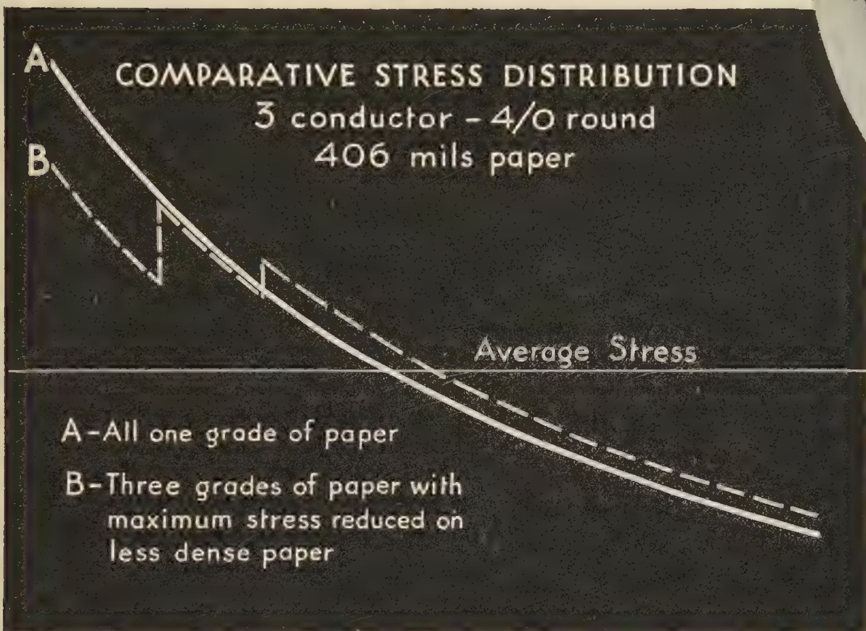

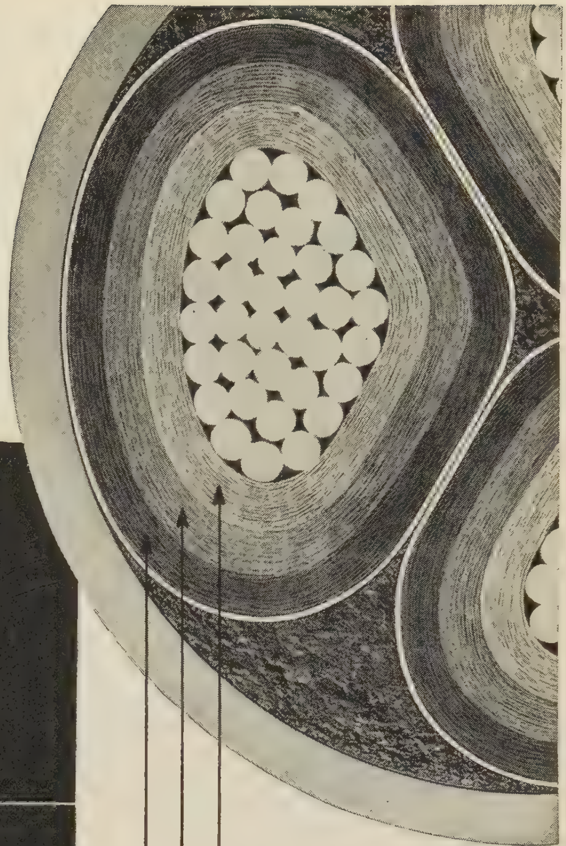

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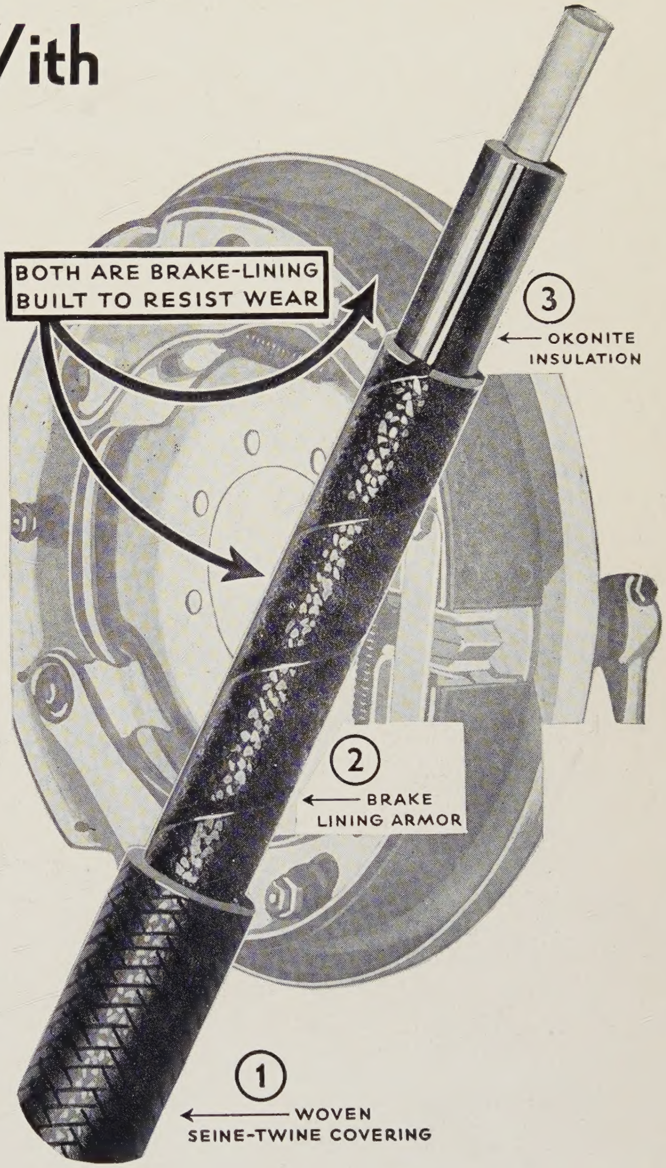

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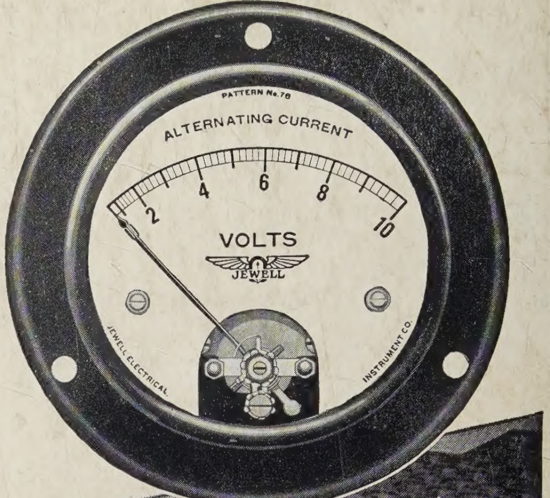

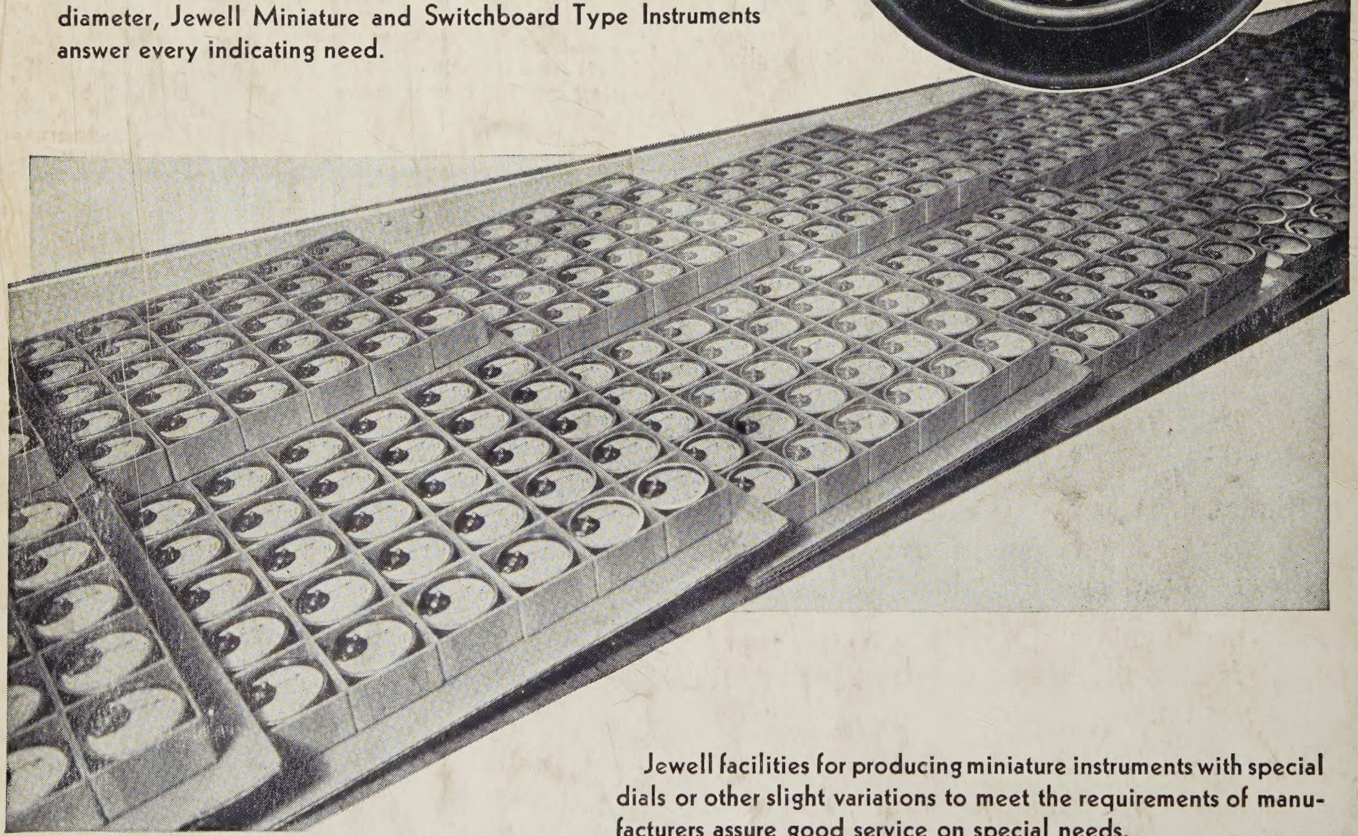

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